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THE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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The new revision of this valuable text places greater emphasis on theory, providing a balanced treatment of applied and theoretical thermodynamics. The material has been expanded and reorganized to provide for greater teaching efficiency, and additional illustrations and reference sources have been included. Problem questions follow each chapter. *March, 1962*

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by L. E. Grinter, University of Florida

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Here is an exhaustive examination of the basic theory of materials and manufacturing processes, written from the viewpoint of the design engineer. More than twenty new subjects are covered in this edition, and many of the discussions already included have been revised and expanded. The text includes over five hundred review questions and problems, almost all of which are new, with solutions available in an accompanying manual. *April, 1962*

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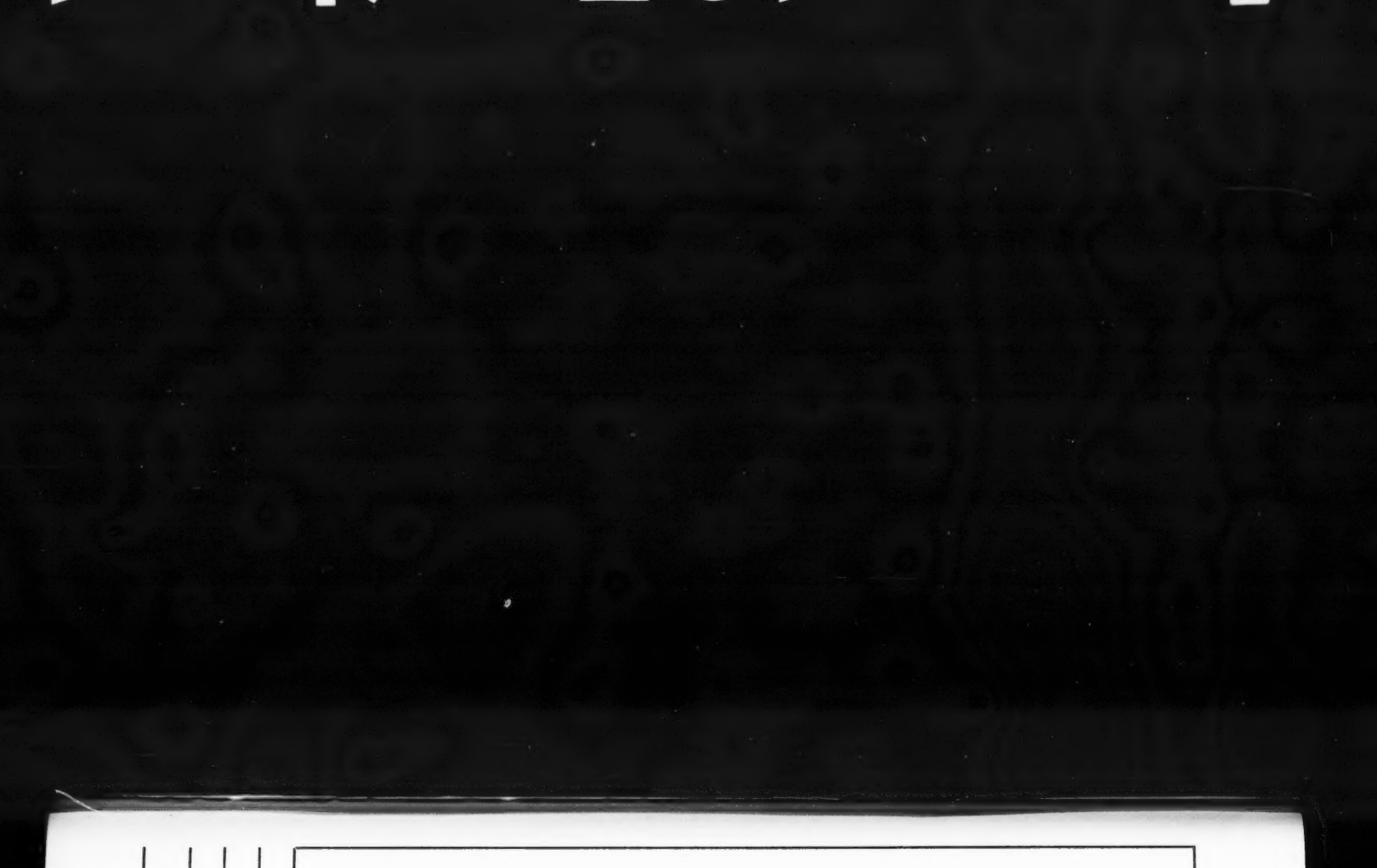

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By DAVID I. COOK and DONALD N. PIERCE, both of The University of Nebraska.

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HEAT-TRANSFER CALCULATIONS BY FINITE DIFFERENCES

By the late GEORGE M. DUSINBERRE, The Pennsylvania State University.

A book which presents a reliable and comprehensive guide to finite-difference methods for heat-transfer calculations. It is built around a series of examples which cover a wide variety of applications. *1961. $10.50. 293 pages.*

ELEMENTARY DIFFERENTIAL EQUATIONS

By L. R. WILCOX, Illinois Institute of Technology; and HERBERT J. CURTIS, University of Illinois, Chicago.

This book reflects the modern trends toward increased emphasis on concepts, ideas, and reasoning. Considerable attention is devoted to domains of solutions of differential equations. The Laplace transform is presented as providing one method of solving linear equations. *1961. $6.50. 273 pages.*

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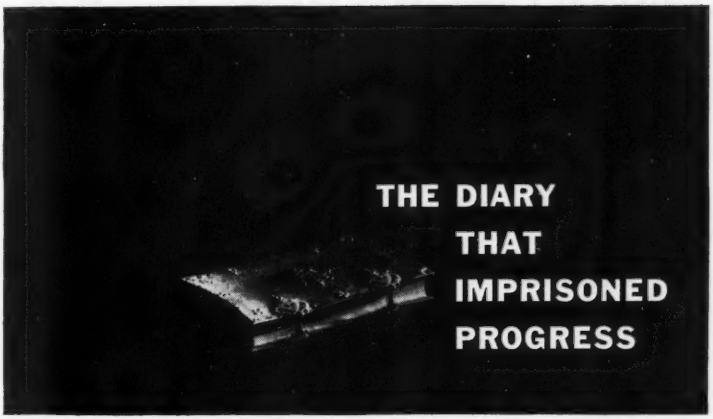

Nearly two centuries ago, Karl Gauss, "Prince of Mathematicians," kept a diary which was destined to become one of the most significant documents in the history of mathematics.

In his diary Gauss jotted down the results of elaborate calculations that had led him to fundamental discoveries in mathematics. But he never published these discoveries, and many of them remained undisclosed during his lifetime.

It wasn't until almost 50 years after Gauss's death that his diary was found and published. Much time and talent, meanwhile, had been spent in duplicating Gauss's efforts. Mathematical progress had been needlessly slowed.

In contrast, today's scientists and engineers are alert to the importance of sharing their findings through publication. In fact, the number of definitive papers published in a scientific or technological field has become a sure sign of the creative effort in that field.

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Wiley BOOKS

PLANT PRODUCTION AND CONTROL

Third Edition

By Charles A. Koepke, *Consulting Engineer.* Like its predecessors, the new edition of this popular text and reference emphasizes the need for a balanced plant organization in which the several groups act as friendly critics of one another and thus provide a source of checking and reviewing agencies which tend to keep the entire organization alert to the most recent developments. The author discusses thoroughly relationships between design engineers and industrial engineers; sales forecasting and inventory control; inventory and production control; industrial engineers and production control; machine loading, plant capacity and operation sheets; and many others.

Modernized and almost completely rewritten, the third edition features a new arrangement of chapters grouped to show first contributing functions and then actual functions for controlling the flow of materials through any type of manufacturing establishment. New chapters have been added on the use of digital computers in production control, operations research and data automation, and cycle scheduling. 1961. Approx. 384 pages. Prob. $8.75.

INTRODUCTION TO TRANSIENTS

By David Kirk McCleery, *University of Manchester.* 1961. 232 pages. $7.50.

ELECTROMAGNETIC THEORY

By Erik Hallén, *Royal Institute of Technology, Stockholm.* 1961. In Press.

FAILURE AND REPAIR OF CONCRETE STRUCTURES

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By Leonard R. Creasy, M.I.C.E., B.Sc. (Eng.) Lond. 1961. 216 pages. $6.75

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By Claude Berge, *Centre National de Recherche Scientifique.* 1961. In Press.

CONCRETE TECHNOLOGY, Volumes I and II

By D. F. Orchard, *University of New South Wales, Sydney.* 1961. In Press.

ELECTROTECHNICAL DICTIONARY;
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By H. Schwenkhagen. 1961. In Press.

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VECTOR MECHANICS FOR ENGINEERS

Edited by H. R. Nara, *Professor of Structures of Mechanics, and Head, Department of Civil Engineering and Engineering Mechanics, Case Institute of Technology, with contributions by* Howard E. Conlon, Robert J. Guyan, Lucien A. Schmit, Jr., *and* Robert L. Swart.

Part I—Statics

Designed as a basic undergraduate book in one of the fundamental engineering sciences, *Vector Mechanics for Engineers* should be of great interest to all teachers of engineering and technology in the United States and abroad. Part I presents an orderly, formal vector treatment of force equilibrium problems in engineering—a subject area which is generally referred to as *Statics*. Assuming a rigorous approach to the problems, each example represents a particular and specific insight into the total engineering complex. Inasmuch as the engineer in design is normally faced with establishing equilibrium, considerable space has been devoted to outlining criteria for achieving a stable structure, and a large portion of the problems have been selected from meaningful real physical examples.
1961. Approx. 422 pages. $6.50.

Part II: Dynamics

This represents a formal vector treatment of *Dynamics* for undergraduate engineering students. The philosophy of the book is to develop the principles of Newtonian dynamics in the most general manner which the authors believe to be consistent with the development of a student at the sophomore-junior level, and then to specialize the general formulation as a process of analysis to the specific engineering problem under consideration. The technical portion of the text begins with a general presentation of kinematics in moving coordinate systems. Next, the fundamental principles of Newtonian kinetics, Newton's second law, impulse and momentum, work and energy, and the concept of potential are developed for the mass particle.

Following this, these same principles are extended to the systems of particles and rigid bodies by the process of summation and integration. In this manner, the student is introduced to the general methods of formulation for the mass particle so that rigid body dynamics becomes a more readily understood extension. An introduction to the specialized area of linear vibrations is included because of its ever increasing importance in modern engineering.
1962. In Press.

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Do You Know

● That ASEE should aim at nothing less than 100 per cent membership of engineering faculties? In particular, we must make every effort to encourage the active participation of the younger faculty members, the industrial representatives, and the faculties of the junior colleges and liberal arts institutions that supply our engineering schools with students. These are the parting shots of Eric A. Walker to last year's Section Chairmen in his "thank you" letter for their efforts and cooperation in his year as President of ASEE. They also constitute a challenge to all current chairmen!

● That the first two companies to affiliate with ASEE by virtue of membership are E. I. Dupont de Nemours and Company, Inc., and the Hercules Powder Company, Inc.? Both memberships date since 1943. This continuous membership of the first two companies to recognize the value of industrial support for engineering education through ASEE is significant, particularly in view of the fact that 19 companies discontinued their memberships last year, presumably because of the "recession." Fortunately, however, even in the "recession," 20 new companies recognized the need for support of engineering education through ASEE and became industrial members! H. E. Heath and his Industrial Membership Committee can't do all the work. You, too, must sell ASEE to your friends in industry.

● That copies of the papers presented at the Workshop on Direct Energy Conversion are available? The workshop was held during ASEE's Annual Meeting and was jointly sponsored by the EE Division of ASEE and the Professional Group on Education of IRE. Copies may be obtained for $2.00 each, while they last, from Professor B. J. Dasher, School of Electrical Engineering, Georgia Institute of Technology, Atlanta 13, Georgia.

● That ASEE endorsed the Conference on Transport Phenomena held at the University of Wisconsin on July 10-22, 1961? The 63 attendees (five from Canadian institutions) came from 50 different institutions and represented nine disciplines. Slightly more than half were chemical engineers and about one-fourth were mechanical engineers. Most of the Conference leaders and teaching staff were from the University of Wisconsin, but there were also a number of guest lecturers. A set of 115 problems and solutions, totalling some 600 pages, and a 400-page laboratory manual were distributed for the exclusive use of each participant. Financial support was provided by the National Science Foundation.

● That the papers presented at the July 1960 Conference on Civil Engineering Education held at the University of Michigan can be purchased from the American Society of Civil Engineers for $1.00? The book is 6 inches by 9 inches, hard bound, and 192 pages in length. The presentation of these papers culminated a series of joint efforts of the Cooper Union, ASCE, and ASEE, under a grant from the National Science Foundation. Appropriate distribution of the resolutions prepared at the conference have been made and institutions have been asked to express their opinions by a letter ballot sent out by ASCE. Orders for the papers should be sent directly to ASCE at 345 East 47th Street, New York 17, New York.

● That "How to Measure Faculty Work Load" is a new booklet published by the American Council of Education? The uses and values of faculty work load studies, various methods of measuring faculty

work loads, and procedures for making a comprehensive faculty load analysis are given. Several forms are included, along with cautions and suggestions on procedure. Copies may be purchased for $1.50 from ACE's Publications Office, 1785 Massachusetts Avenue, N. W., Washington 6, D. C. The author is J. E. Stecklein of the University of Minnesota.

• That the employment of scientific and engineering faculties at colleges and universities increased 34 per cent from 1954 to 1958? This compares to a 30 per cent increase of total staff. Slightly more than half of the 311,000 professional personnel employed by colleges and universities in March of 1958 were scientists and engineers. Of the 211,000 reported as faculty, 100,000 were scientists and engineers. Of the 100,000 non-faculty professional personnel, 57,000 were scientists and engineers. Slightly less than 20 per cent of the 157,000 science and engineering personnel were engineers. These are some of the highlights of NSF's *Scientific Manpower Bulletin,* No. 13, July, 1961, available for 10c each from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

• That 44 per cent of the 157,195 scientists and engineers at U. S. colleges and universities during 1958 were engaged in research and development? For engineering the percentage is 48, and the total number engaged in research is 12,236. Life sciences has a percentage of 53, physical sciences 48, and social sciences 24. A comparison of data for 1954 and 1958 indicates that to meet the need for additional manpower, universities have relied on the allocation of more faculty time rather than on increasing the number of faculty engaged in research and development. The number engaged in research and development increased by only three per cent during those years while the number engaged full time increased by almost 50 per cent. These data come from Reviews of Data on Research and Development, No. 27, *Scientists Engaged in Research and Development in Colleges and Universities,* 1958, Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 10c each. The study was made by the Department of Health, Education and Welfare, Office of Education, for the National Science Foundation. Questionnaires were mailed to 1,916 independent and autonomous institutions of higher education in the United States.

• That *New Thinking in School Mathematics* is a 246-page report of the Office for Scientific and Technical Personnel of the OEEC? In attempting to strengthen the European economy, OEEC ran squarely into the severe shortage of scientific and technical manpower and hence became interested in basic science and secondary school mathematics education. A survey of mathematics education in 20 member countries served as a basis for an international seminar attended by more than 50 mathematicians and educators. The purpose of the seminar was to define the content and the methods of modern mathematics education and to formulate suggestions in recommendations for a reform of curricula. *New Thinking in School Mathematics* is the report of the seminar. Copies may be purchased for $2.50 from OEEC Mission, Publications Office, Suite 1223, Connecticut Avenue, N. W., Washington 6, D. C.

• That according to the report of the team of engineers EJC sent to the USSR last year, the USSR annually graduates approximately 117,000 engineers? This compared to 38,000 for the United States for the same year. Soviet plans call for substantial increases in that number, whereas the immediate trend in the U. S. is downward. The report, *The Training, Placement, and Utilization of Engineers and Technicians in the Soviet Union,* is available in limited numbers for $1.00 each from EJC at 345 East 47th Street, New York 17, New York.

• That *The Engineer in Industry in the 1960's—a Professional Program* is a new book published by NSPE? The publication takes a look at the engineer in industry, his goals, his problems, and what can

be done to help his search for professionalism. The book brings out that the engineer wants to be considered a part of the management team, to use his professional training to the fullest, to gain proper professional recognition, and to be paid a salary equal to his contribution. Other pertinent statements are that salaries of experienced engineers have increased at a slightly greater rate than starting salaries since 1956, and that engineers are less and less inclined to turn to unionism to achieve their aims. A detailed proposal for a cooperative program of joint action by management, the individual engineer, and the professional societies is also included. The 148-page book can be obtained for $4.00 per copy, $2.00 to NSPE members, from NSPE, 2029 K Street, N. W. Washington 6, D. C.

• That 21 Cleveland companies have initiated a program designed to triple the amount of money U. S. corporations are giving to higher education? It is recognized that corporate support of higher education takes many forms, including capital gifts, scholarships, unrestricted operating gifts, endowed professorships, and research grants, among others. It is not the purpose of the Cleveland plan to influence the type of gifts that corporations make to higher education nor to suggest which institutions should receive the gifts. The plan is to increase corporate giving in general, leaving each company free to support projects at institutions of its own choice. The 21 corporations in signing the original document, with authorization from their boards of directors, agree to, "Make increases in corporate contributions commencing at once and increasing within three years to a minimum of not less than one per cent of income before taxes and thereafter gradually increasing as the need develops."

• That the suggestion has been made that each engineering society establish a "Committee on Corporate Giving" to increase corporate support of education, science, and welfare? The suggestion was made by Dr. M. G. Malti of Cornell University at the summer general meeting of AIEE, and was based on the fact that engineering societies include among their members, representatives of all the important corporations in the United States. With each society establishing a committee, the chairman of the separate committees could become members of a joint engineering committee on corporate giving which would have as its purpose the study of corporate giving and its implications, the review of papers on the subject, and the stimulation of interest and expansion of corporate giving. Corporations apparently are unwilling to take full advantage of the 5 per cent they can deduct from net income before taxes because during the 15 years since the law has been in effect the average contribution has been about 0.645 per cent.

• That the offices of EJC and ECPD are now located in the new United Engineering Center? The address is United Engineering Center, 345 East 47th Street, New York 17, New York. That also is the address for the organizations for which EJC is the secretariat—Engineering Manpower Commission, IAESTE, U. S. Committee on Large Dams, and the World Power Conference, as well as for *"Engineer,* EJC's national newspaper. This move accompanies that of eight member societies of EJC into the new building.

• That the Institute of Radio Engineers and the Institute of the Aerospace Sciences are now members of ECPD? Both were elected to membership by unanimous approval of the eight participating bodies of ECPD. The new president of ECPD is R. A. Morgen, President of Rose Poly; the new Vice-President is W. Scott Hill of GE, and the Secretary is O. E. Kirkendall of AIME. Dean W. P. Kimball has been elected vice-chairman of the Education and Accreditation Committee for 1961-62.

• That about 25 per cent of all ROTC graduates are engineering students? Comparison of this figure with the 18 per cent of all male students who are engineering students indicates that ROTC is enrolling more than a proportionate share of engineering students in spite of ECPD ef

other restrictions. This comes from the minutes of the meeting of the Executive Committee of ECAC, June 29, 1961.

• That of the 248 individual members dropped for non-payment of dues for two years, 84 were in the "under 36" category and 10 had "turned 36?" Only 41 of the 248 joined prior to 1950, whereas 56 joined in 1958. Of the 501 members delinquent one year, 161 were in the "under 36" group.

• That "Interdisciplinary Challenges in Engineering Education" is the theme for next year's Annual Meeting at the Air Force Academy? The dates are June 18-22, so mark them on your calendar.

• That of the 465 new members last year under 36 years of age and with designated academic titles, almost 16 per cent had ranks above assistant professor? Almost 1 per cent were assistant deans or department chairmen, 2.1 per cent were lecturers, 2.6 per cent were professors, 10.3 per cent were associate professors, 34.2 per cent were assistant professors, 45.4 per cent were instructors, and 4.5 per cent were assistants of various types.

W. Leighton Collins
Secretary, ASEE

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ADVANCES IN QUANTUM ELECTRONICS

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Edited by Normal Mather and Clifford Mannal. Up-to-date and advanced information on a new highly specialized field of engineering interest and economic importance. The simple principle—that fuel passed through a magnetic field creates an electrical current—is revolutionizing electrical power production. The book is divided into four main sections: Flight Application; Power Conversion; Communications and Diagnostics; and Fusion. *$7.50.*

Columbia University Press New York 27, New York

MH COLLEGE DIVISION

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By ROBERT PLONSEY and ROBERT E. COLLIN, Case Institute of Technology. *McGraw-Hill Series in Electronic and Electrical Engineering.* 554 pages, $12.75.

A thorough and complete treatment of basic electromagnetic fundamentals, with a detailed and broad coverage of applications. Beginning with a thorough introduction to vector analysis, the text leads into a careful treatment of electrostatics, stationary current flow fields, magnetostatics, time varying fields and Maxwell's equations. Separate material introduces the "separation of variables" and "conformal mapping" techniques for solving Laplace's equation. The last three chapters cover a variety of important and representative applications of current interest.

WRITING FOR ENGINEERING AND SCIENCE

By TYLER G. HICKS, The Cooper Union School of Engineering. Available now.

A basic and comprehensive coverage of the field of modern technical writing. Its aim is to provide engineering, science, and technical writing students, practicing engineers, scientists, and writers with a basic understanding of the methods of effective writing, together with a case-study of numerous examples.

AUTOMATIC CONTROL ENGINEERING

By FRANCIS H. RAVEN, University of Notre Dame. *McGraw-Hill Mechanical Engineering Series.* Ready in September, 1961. 402 pages, $11.50.

A text in control engineering aimed primarily at mechanical engineers. Its aim is to develop and explain the principles of feedback control systems in a manner appropriate to such readers. The first half of the book is concerned with the principles and fundamental concepts of feedback control systems; the latter half correlates basic theory with the more practical aspects involved in the design of feedback systems.

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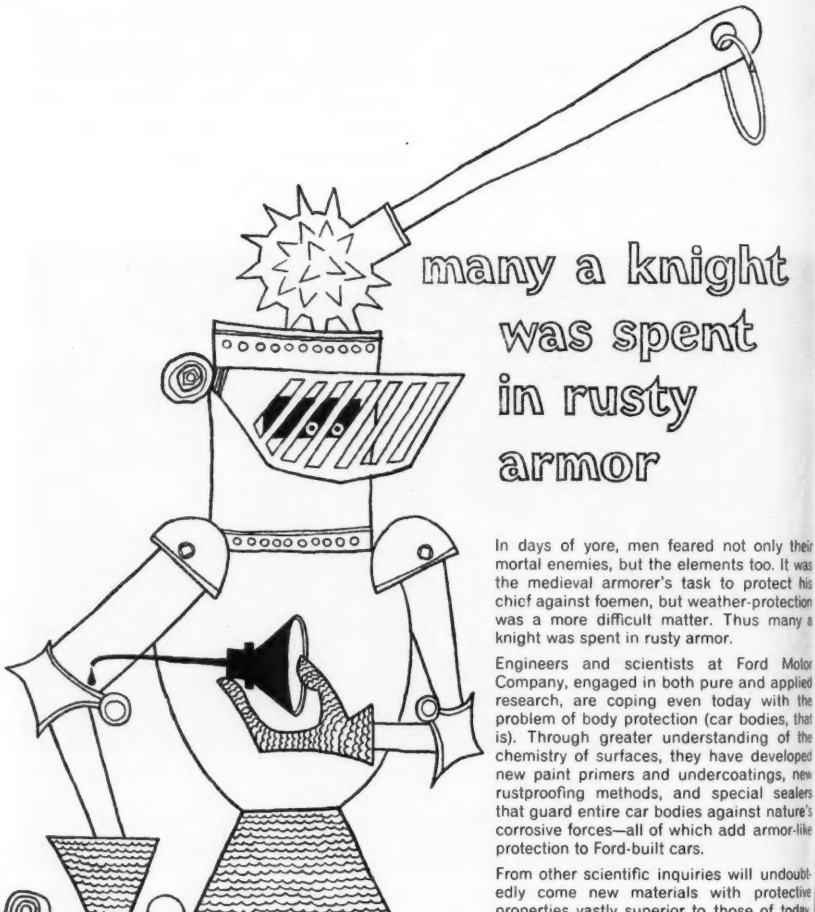
Summer Institute for Engineering Teachers

The Second Summer Institute for Engineering Teachers, held at Penn State August 27-September 9, was aimed at giving selected young teachers a chance to study and practice successful teaching procedures and at supplying mature teachers with materials and information so that they can conduct similar programs on their own campuses. The Institute was sponsored by the Pennsylvania State University in cooperation with ASEE and the Engineers' Council for Professional Development, with financial support from the Ford Foundation.

YETs, METs (young engineering teachers and mature engineering teachers), and speakers participating gathered during the institute for the two group portraits on these pages. In the first photograph, the participants, as numbered for identification, were (1) R. W. Brown, Norwich University; (2) B. B. Mazanti, Georgia Tech; (3) P. L. Johnston, Univ. of Kansas; (4) R. W. Smith, South Dakota Mines; (5) I. P. Badger, Ohio Univ.; (6) W. A. Wiksell, Louisiana State Univ.; (7) R. L. Gonzalez, Bradley Univ.; (8) V. L. Kenyon, Jr., Duke Univ.; (9) J. W. Brooks, Queen's Univ., Kingston, Canada; (10) J. D. Waugh, Univ. of South Carolina; (11) S. G. Huber, Ohio State Univ.; (12) J. F. Engle, Oregon State Univ.; (13) P. W. Klock, Univ. of Illinois; (14) A. B. Wood, Univ. of Tennessee; (15) D. C. Fritz, Univ. of Washington; (16) R. J. Stone, Drexel Institute of Technology; (17) H. W. Vreeland, Columbia Univ.; (18) E. J. Monahan, Newark College of Engineering; (19) L. C. Domholdt, Case Institute of Technology; (20) R. W. Hansen, Colorado State Univ.; (21) V. E. McBryde, Univ. of Arkansas; (22) H. L. Dowell, Jr., Univ. of North Dakota; (23) Stanley Middleman, Univ. of Rochester; (24) J. E. Senne, Washington Univ.; (25) G. J. Trammell, Louisiana Polytechnic Institute; (26) W. H. Schlimmeyer, Rutgers Univ.; (27) O. E. Lancaster, Penn. State Univ.; (28) A. S. Weaver, Michi-

gan College of Mining and Technology; (29) F. L. Whaley, Penn State Univ.; (30) C. T. Grace, Univ. of New Mexico; (31) D. E. Griffith, Univ. of Houston; (32) J. R. Bayless, Missouri School of Mines and Metallurgy; (33) E. D. Jordan, Catholic Univ.; (34) Edward Kraybill, Duke Univ.; (35) Daniel Frederick, V. P. I.; (36) C. E. Schaffner, Brooklyn Polytechnic; (37) P. E. Torgerson, Oklahoma State Univ.; (38) D. F. Fitzgerald, Mississippi State Univ.; (39) D. C. Beppler, Penn. State Univ.; (40) C. H. Kindig, Bucknell Univ.; (41) R. W. Newcomb, Stanford Univ.

In the second photograph, the participants, as numbered for identification, were (1) Joseph Totaro, U. S. Dept. of Health, Education and Welfare; (2) D. I. Cook, Univ. of Nebraska; (3) J. C. Lysen, Iowa State Univ.; (4) H. L. Mason, Univ. of Kentucky; (5) J. S. Jamison, Jr., V. M. I.; (6) R. V. Peringer, Univ. of Akron; (7) G. A. Corser, Washington State Univ.; (8) R. W. Tyler, Center of Advanced Studies in the Behavioral Sciences; (9) J. F. McLaughlin, Purdue Univ.; (10) C. R. Bissey, Kansas State Univ.; (11) J. C. Martin, Clemson College; (12) E. W. Weaver, Univ. of Toledo; (13) D. C. McKee, Louisiana State Univ.; (14) P. L. Koepsell, South Dakota State College; (15) William Wallace, Rensselaer Polytechnic; (16) K. B. Schnelle, Jr., Vanderbilt Univ.; (17) Wilfredo Hernandez-Lopez, Univ. of Puerto Rico; (18) R. H. Bernhard, Cornell Univ.; (19) C. N. Gaylord, Univ. of Virginia; (20) D. C. Scouten, Southern Methodist Univ.; (21) C. E. Harp, Univ. of Oklahoma; (22) R. C. Pitts, Auburn Univ.; (23) J. C. Osborn, Lehigh Univ.; (24) William Weaver, Stanford Univ.; (25) R. G. Griskey, Univ. of Cincinnati; (26) H. L. Huffman, Montana State College; (27) H. A. Foecke, Notre Dame Univ.; (28) J. F. Grove, Univ. of Rhode Island; (29) Walter Rand, C.C.N.Y.; (30) R. M. Barnoff, Penn. State Univ.; (31) W. A. Stout, Michigan State Univ.; (32) W. L. Harris, Univ. of Maryland; (33) Cornelius Wandmacher, Univ. of Cincinnati; (34) Edward Rising, Univ. of Massachusetts; (35) D. R. Carlin, Jr., Lamar State College; (36) P. D. Cribbins, Univ. of North Carolina; (37) D. L. Stinson, Univ. of Wyoming; (38) R. H. Fletcher, Texas A. & M.; (39) C. G. Salmon, Univ. of Wisconsin; (40) W. V. Rusch, Univ. of Southern California; (41) A. A. Hoffman, Jr., St. Louis Univ.



many a knight was spent in rusty armor

In days of yore, men feared not only their mortal enemies, but the elements too. It was the medieval armorer's task to protect his chief against foemen, but weather-protection was a more difficult matter. Thus many a knight was spent in rusty armor.

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MEMO

To: All members of the American Society for Engineering Education

From: R. W. VAN HOUTON, ERIC A. WALKER, R. H. ROY, R. J. MARTIN

This past year was an exciting and stimulating one for the Society. Practically all ASEE policies and procedures were questioned, discussed, reappraised. A new awareness of the importance of engineering in American society took hold, and an increased willingness to accept the responsibility that goes with that importance was felt. Bold and vigorous beginning steps were taken to recast the Society to accept those responsibilities.

The Long-Range Planning Committee proposed a reorganization plan to replace our present cumbersome machinery. The Constitution and Bylaws are being restudied. A committee has been appointed to study the desirability of moving the Society's headquarters to Washington, D. C., or New York City, or having it remain on a college campus. Liberal arts and junior colleges with interests in engineering education were invited to join in our discussions and to help wih our problems. The Executive Board and the ECRC approved the establishment of a Technical Institute Council. The Annual Meeting Committee announced Interdisciplinary Challenges in Engineering Education as the theme for the 1962 annual meeting at the Air Force Academy and called for papers. Suggestions for the improvement of sectional and divisional publications were received.

In our opinion, this is a sound beginning and these are sound proposals. But how far and how fast ASEE moves forward depends not so much on its officers as it does on the interest and commitment of its members. The vigorous beginning that has been made cannot be sustained for very long without the wholehearted support of each and every member. Only the members can change the Constitution and effect a reorganization. Only the members can submit the papers that will generate important discussions at annual meetings. Only the members can guarantee significant divisional newsletters. Only the members can provide the basic strength the Society must have if its voice is to be heard and listened to.

The October issue of the *Journal of Engineering Education* carried the report of the Long-Range Planning Committee as presented to the General Council at its Friday meeting in Lexington. On the recommendation of the then-president, Eric A. Walker, it was decided to postpone action until the November meeting of the General Council, in order to give the members ample time to study the proposed reorganization.

We, the undersigned, urge every member of the Society to study carefully the report of the Long -Range Planning Committee. In our opinion, the proposed reorganization makes possible a much more effective organization than at present. If approved, as we hope it will be, the Society will be able to take prompt action on the important problems facing engineering education and to have its voice heard on proposed national legislation af-

fecting engineering education. Under the present organization from six months to a year must elapse before action can be taken on many important matters because of our present cumbersome machinery.

We wholeheartedly recommend approval of the proposed reorganization by the General Council. Once approved, the Constitution and Bylaws Committee can proceed to draft a revised constitution and bylaws, which will be brief, concise, and unambiguous for letter ballot approval by the members in the spring of 1962. The Society then can begin to function under the new plan on July 1, 1962.

The ASEE is your society; engineering is your profession; education is your duty and your privilege. Make them something of which you can be proud. The improvement of engineering education is the goal of every member; let's all pull together for its improvement.

Review of Engineering Research

Over 11,000 research projects are in progress in 121 leading engineering colleges throughout the United States, Professor Ross J. Martin, chairman of the Engineering College Research Council, told the American Society for Engineering Education at the Annual Meeting in Lexington.

During the 1960 fiscal year over $180 million has been expended on research projects in these engineering schools—the highest volume of research ever recorded in 17 years of surveys by the Engineering College Research Council.

Professor Martin, director of the University of Illinois Engineering Experiment Station and a vice president of ASEE, reported the new figures at a joint meeting of the ECRC and the National Council of University Research Administrators, part of the annual meeting of the ASEE at the University of Kentucky.

"The increasing quantity and quality of basic research in engineering colleges is an excellent indication of the strength, vigor, and progress of the engineering profession in the United States," Professor Martin said. "At a time when basic research is necessary to provide technological superiority in the world, engineering college research is serving the needs of the nation," he continued.

"In addition to bringing forth new knowledge, engineering college research serves another purpose: it provides for the advanced education of students who, upon graduation, contribute creatively to the increasingly complex technology of the future."

More than 16,000 engineering faculty members and their graduate students are devoting part-time to research in engineering and the engineering sciences, Professor Martin said. Their role in research assures that these teachers have increased competence and their students a far more complete academic experience, he pointed out.

The statistics cited by Professor Martin were taken from a new edition of the Engineering College Research Council's *Engineering College Research Review*. Copies of the research review are available at $4.00 each from the Secretary of ASEE at the University of Illinois, Urbana.

International Relations and Engineering

MYER COHEN

Director, Bureau of Operations for the United Nations Special Fund

As engineers, you have had to subject yourselves to the kind of mental discipline which goes with planning and with logistics. However, you are, I believe, accustomed to deal with the type of variables which can be controlled with a relative degree of certainty. Those of us who work internationally in the social and economic fields, think of ourselves sometimes as "social engineers." I hope you will not consider that phrase a contradiction in terms. Scientists frequently are amused at the phrase "social scientist" and say that social science is a pseudo science. Yet, the fact remains that we, "social scientists," we "social engineers" must try through the use of such mental discipline as we have learned, to describe problems, adopt practical measures for dealing with them, and evaluate the potential results of different courses of action.

All of us, whether engineers or international officials dealing with social and economic problems, find ourselves faced with what has been described as the revolution of rising expectations. This is a dramatic fact of the present day world. Millions and millions of people are seeking with incredible rapidity to find their place in the world and to orient themselves toward the complex international scene. These millions are enamoured by the prospect, and in some instances by the fact, of political independence. I am certain that when Woodrow Wilson spoke of the doctrine of self-determination of nations at the conclusion of World War I, he had no image of the kind of problems with which the people would be faced in the course of a political evolution which would lead to a proliferation of new and, in many cases, relatively small and economically non-viable national states. Many of the leaders in these new states are learning the hard realities as well as the economic burdens which accompany political independence. Please understand that I am not passing judgment on the desirability or undesirability of these developments. I am merely describing them.

It is not meaningful to give statistics on these developments: It is sufficient to say that the number of people affected runs into the billions, and that the areas affected are not restricted to any one continent. I think that you as engineers must take your fair share of the responsibility for the changes—political, economic, social—which are taking place with such tremendous speed, since clearly, modern technology has been a principal contributing factor.

Presented at the ASEE Annual Meeting, June, 1961.

The Revolution of Rising Expectations

I should like to discuss with you some of the critical problems arising from, and accompanying the revolution of rising expectations, and how we in the United Nations are attempting to tackle these problems.

We are encouraged by the fact that each day brings new evidence of the richness of the physical resources of many of these countries. In fact it is becoming increasingly evident that from the point of view of resources the traditional classification of "rich" and "poor" lands is no longer correct or meaningful. It is more useful to look at the problems in terms of degrees of under-utilization of existing resources. Many of these countries

just don't know the possibilities of putting larger areas of their land into agricultural production or increasing productivity of land under cultivation, for instance through irrigation; of harnessing their rivers to produce electricity; of opening up mineral deposits or developing large-scale fishing or other industries. Some hint, for example, of the untapped agricultural potential lies in the fact that farm output in metric tons per person on the North American continent is ten times as high as the average in Asia, and twenty times higher than in Africa.

The United Nations and its Specialized Agencies have had rich experience in assisting countries to discover what their natural resources are, and in demonstrating the feasibility of putting them to productive use. The newest of the U. N. agencies in thie field is the Special Fund. It was created to expand greatly United Nations assistance in investigating natural resources in the low income countries and in training and helping their people to make effective use of those resources. Let me give a few examples.

The Niger River in Africa is a specific example of a rich but little-used resource and of United Nations assistance to make at least part of it more productive. A study for the development of a section of that river is being carried out with Special Fund help through the International Bank. In fact, it is just about completed. There is every evidence that, with the construction of a dam 150 feet high, that waters of that river will be available for the irrigation of thousands and thousands of acres of potentially rich land, for the generation of millions of kilowatts of cheap power, and navigation on the river will be greatly improved.

Let me give another specific example from another country—Ethiopia—and again in the vital field of increasing agricultural output. One of Ethiopia's principal rivers is the Awash. Here too, its waters have been used but little and yet preliminary studies indicate that, with control of the waters of that river, the Awash Valley can become one of the more fertile valleys in all of Africa. In fact, the prospects of this are so bright that a British syndicate signed an agreement with the Ethiopian Government to supply $35,000,000 of capital for a settlement project in the Valley, provided the intensive soil and water-use survey, now under way with United Nations assistance, through the U. N. Food and Agricultural Organization, measures up to the preliminary findings.

From this example you will have already grasped one of the principal reasons for these surveys: They have a vital role to play in laying the groundwork for substantial investment, domestic and foreign. Dramatic evidence for this is in an Argentine project assisted by the Special Fund, also through the World Bank, and completed last summer. In the report on this survey, a team of British and American engineers and economists show that prospective revenues will fully support an investment of some $735,000,000 over the next ten years for facilities to provide the electric energy Argentina needs for industrial development and home use.

Human Resources

Fortunately, the discovery and evaluation of the *physical* resources of a country are not too difficult. Whether it is soil, water, minerals, petroleum, fisheries or timber that is to be investigated, techniques are available and constantly improving. Mineral exploration illustrates this. Today with low-flying airplanes and modern equipment it is possible to prospect 100 square miles in less time—and more thoroughly—than it would have taken to prospect one square mile by traditional methods. The problems of physical resource surveys are only those of time and money, and trained personnel.

The task of making more effective use of the *human resources* of the low-income countries is infinitely more difficult and more time-consuming than is that of better utilizing physical resources, and it requires even more money. Yet this task is the most critical of all in promoting economic progress and social advance. Every low-income country is extremely short of trained government administrators, tech-

nicians, engineers, and other professional men, teachers, business leaders and skilled workers. It is no exaggeration to say that if they now had adequate supplies of such highly trained personnel, their natural resources would already be producing the food and much of the other goods their people need.

Of the 1,300 million people now in the 100 underdeveloped countries associated with the United Nations, I would guess that around 750 million of those at or over school age still cannot read or write. Scores of millions of these people must learn to read and write and must be given secondary education as well. There are also immense needs for vocational training. And finally, as an overriding factor in economic development, we have the necessity of training vast numbers of people for highly skilled occupations. As a conservative estimate, I would say that our hundred underdeveloped countries need to train one million people as rapidly as possible for such posts—top-level administrators, professional personnel, including of course engineers, management and business executives, and middle-level technicians for building and industrial programs, for health services, teaching, and for supervisory positions in government and industry.

This is a staggering job, one that is impossible with the resources currently available for it. Happily, educational and training programs of the United Nations and its specialized agencies are being stepped up. But a much greater effort, national and international, is required; there is no time to lose in really getting on with this task, *for education and technical training must go on in advance of significant economic development.*

We in the Special Fund are trying to concentrate our efforts in the training field so as to get the maximum results.

Our assistance in technical education so far covers a wide variety of components conducive to the development of the human resources of the underprivileged nations and to the establishment of the human factors which are prerequisites of both industrialization and of economic development generally.

Manpower with industrial training is needed for the employment of modern tools and instruments and new supplies of energy, and to operate and maintain equipment.

We, therefore, support through the training of instructors the training of skilled workers, of foremen and supervisors at all levels. In India, for instance, a number of projects have been designed to train the instructors for 250 government-operated training centers for industrial trades which, at the end of India's third Five-Year Plan, will have 100,000 craftsmen under training. Bilateral assistance projects too have been integrated with the Special Fund projects, aiming at supplying India with the industrial manpower required for her development. When fully organized with international advisers at the ministerial level, apprenticeship experts in the main regions and international instructor teams at the instructor training centers, the Special Fund will make available assistance at a cost of some $3.8 million, to which India will contribute more than $9 million for the instructor training, and invest the equivalent of some $100 million in the craftsmen training centers to be staffed with these instructors. These projects illustrate how international assistance, if well conceived and concentrated on elements of key importance, can have a large multiplier effect and an essential impact on a country's progress. Projects in the field of industrial training by means of instructor training receive Special Fund support in quite a number of countries, such as Israel, Peru, the United Arab Republic, Yugoslavia and others.

Other projects cover the training of technicians and engineers at both polytechnic and the university levels. Special Fund assistance to Pakistan in the amount of some $2.3 million provides teaching program advisers, teaching experts and teaching equipment to a number of technical schools to improve the standard of teaching and to increase the number of graduates who are needed, not only for the general development of

the country, but also in particular for the water replacement works under way in the Indus Basin at a cost of about $1 billion. This project is tied in with the recent treaty signed between India and Pakistan on the Indus which was successfully negotiated by the World Bank. In other countries such as Morocco and Iran we are supporting schools of engineering at university, polytechnics for the training of intermediate-level engineers and technical institutes which produce technicians below the engineer level.

A number of other projects deal with the training of technical personnel for key sectors of a country's economy, such as railways, civil aviation, and telecommunication personnel. Projects of this type are being undertaken in Libya, Mexico, the Philippines and Thailand. In Iraq, Malaya and Argentina projects aim at the training of management and the introduction of better productivity techniques.

The Special Fund has recently decided to support projects for training in economic planning which it is hoped will fill *an enormous* gap, and for the establishment of manpower planning services. Training projects in these fields are expected to materialize by the end of 1961. At the beginning I referred to social engineering. These are apt examples of work in this field.

Complexity of Development Assistance

I have talked about *projects* of various types without being very concrete about what exists behind the word itself. So often in our work we get so accustomed to using our own jargon that we assume the words have a universal meaning.

Let me make an effort at clarification by describing the difficulty and the complexity of providing development assistance. I have the feeling that the process itself is widely misunderstood, and that there is a tremendous gap between fact and fancy. Some people think of foreign aid as charity, as a philanthropical giving of specific objects or items. I am concerned with a system based on mutual participation in development,—a partnership between the government of a low-income country and those providing the assistance. This involves a long hard process. It starts with the glimmerings of an idea, has to be developed through the local institutions, has to fight its way for a priority inside the local and national government, has to secure local financing, (because as I will explain later, we in the Special Fund require local contributions, substantial ones for our aid). Then the request comes to the staff of the Special Fund; there we evaluate it, question it, and finally recommend it to our Governing Council for approval. Thereafter the project must be implemented. This is no simple task, especially in an underdeveloped country, but the very process is itself educational in the best sense. It carries with it a sense of participation, and sense of responsibility, and a recognition of the fact that while the assistance is temporary, the institution being assisted, if it is a training or a research project, is expected to continue as a going institution. We will not assist a training or research institution unless we are sure that at the end of our assistance it will be taken over and continued by the recipient government or by a national institution.

On surveys of natural resources, we do not go in unless there is a reasonable prospect of investment to follow if the feasibility report is positive. We do not make general surveys in the dark, so to speak, but require reasonable prospects for fruitful intensive study, and for investment.

One of the big questions in connection with aid to underdeveloped countries is the choice of the most effective and economical instrument, which may or may not be the United Nations.

I would suggest that a pragmatic approach be employed in determining to what extent aid should be given through the United Nations, through regional organizations or on a bilateral basis. The channels to be chosen are those which will yield the most effective development in a given situation. I would be less than frank if I did not say that if this test

is applied the result is certain to be a substantially increased use of the United Nations. There are several reasons—first, because in the U. N. and its fourteen specialized agencies reposes the richest experience that can be found everywhere in virtually every field of developmental activity. The U. N. draws on the whole world for its technicians. Second, assistance through the U. N. guarantees that there is no paternalism. U. N. assistance is a completely cooperative endeavour with a voice given to countries whatever their size or wealth and with all countries contributing to the cost. Third, because the low-income countries prefer assistance through the U. N., and know that its aid is financed by more than eighty countries, both rich and poor, it is possible for the U. N. to insist that the recipient countries put forth a maximum of self-help. As proof that this can be done, I cite the fact that the Special Fund's contribution to the 57 projects approved by its Governing Council is $131 million, and that of the recipient countries, $174 million for a total of $305 million.

Having said this I would like to make it clear that this is not a question of all aid through the U. N.—or all aid bilaterally. There is need both ways, but I firmly believe a larger amount should be channelled through the U. N. than there has been to date.

It is important that the best channel for each situation—political, economic and psychological—be utilized, but it is even more important that we act with a sense of urgency. If we apply ourselves to the job with vigor and imagination there is no reason why an undreamed rate of progress cannot be achieved. On what do I base this assertion?

In the first place nearly all of the 100 low-income countries associated with the United Nations have, as I have said, in their physical and human resources the potential means for achieving decent standards of living for their people. The problem is to get these resources into production multiplying today's output of goods and services.

The second reason for cautious optimism is that modern science has provided intellectual and mechanical techniques capable of expanding productivity enormously. Not the least of these tools is that of building—in, through investment in organized research and development work, the leaven for sustained economic growth.

The third factor offering some promise of reasonable progress is that we have over recent years developed machinery, national and international, specifically designed to facilitate economic and social advance. These institutions, though often very rudimentary, are vehicles for rethinking ways society can help fulfill human needs, and are instruments for inducing desired changes; e.g., through the judicious application of knowledge and capital, manpower and goods, to make economics more efficient. Organizationally, too, we are not starting from scratch.

The Basic Ingredient

I fear I have roamed far and wide in my effort to share with you my thoughts on the somewhat vast topic which you entrusted to me. I would like to reiterate that the revolution of rising expectations is essentially a technological revolution and one in which you as engineers have a vital role. Therefore let us bring into focus the possible contributions you can make toward meeting these problems.

Governments come and go; institutions are created and then fall into disuse; but the basic ingredient is always MAN and MEN. Educators are, of course, in a key position not only to recognize this, but also to make a significant contribution toward improving the quality of men who work in the field of engineering. There is a tremendous need for civil engineers and for engineers equipped to transfer, through teaching, research techniques to newly developing nations.

The task of assisting these new nations is far more complex than is generally realized. It is not merely a question of sending persons with excellent technical training out to do the job. "The job" re-

quires a great deal more than technical know-how—it also involves training, adapting and inspiring. It requires, not only a knowledge of psychology and anthropology, but also an intuitive ability to appreciate the folkways and mores of persons having a totally different outlook on life, and daily habits quite different from our own. All of you know the problems of teaching in our own country; when to these are added differences in culture along with the psychological factors which come into play when persons from more developed countries attempt to advise and teach persons in less-developed countries, the complexity of the task becomes apparent. A number of years ago I was responsible for a short period of time for the recruitment of experts to be sent on technical assistance missions. Those of us dealing with this have pondered and discussed over the years the ingredients required for success as an expert working in a foreign country. How can the required qualities be developed in men and women? The search for a complete answer to these enigmas would take us even further afield than we have gone so far. My purpose in mentioning the subject at all is to underscore the point that non-technical factors, that is, non-technical from an engineering point of view,—are among the most important factors of all. I do not mean to belittle the need for technical competence—but I want to emphasize the indispensability of psychological and cultural understanding, along with technical competence, and the significance of the personality structure of individuals being sent into what for them are novel situations. Rigid personalities who want to make the world over in their own images, and who have little tolerance for "foreign" ways of doing things, cannot be very helpful in international development assistance regardless of the other normal technical competence they may possess.

My stressing of these matters is not merely because of an interest in having engineers available, for work in less-developed countries, who have a broad understanding of cultural differences. I believe that all of us must be concerned with the impact of and interplay between international relations and ourselves—whether we be engineers, or international officials dealing with social and economic problems. The world today requires men and women whose education prepares them for the realities of the present—and of the future. Modern science has brought us all together—but as we all know only too well, we have yet to learn to live together.

I would like to close by describing for you the kind of experience I face daily at the United Nations. I believe you may find it pertinent to the remarks I have just made with regard to cultural differences, and their significance. On my staff at the United Nations, I have three Frenchmen, two Englishmen, two Dutchmen, one German, one Austrian, one Norwegian, one Russian, one Jordanian, one Canadian, one New Zealander, one Indian, three Americans, one Dane, one Swede, one Swiss, one Turk. It is our job to work together, to discuss policies, to develop procedures, and to deal with the complex business of providing assistance in the pre-investment field to underdeveloped countries. Rarely a day passes without the special cultural characteristics of several of these individuals appearing on the scene; one day it will be over-sensitivity, another day stubbornness, another day literal-mindedness, another day excuses, and failure to take responsibility or admit error—and so on. But, we are learning albeit slowly, and with some stress and strain, to perform with increasing ease and efficiency the everyday work of the world through the United Nations. What we are endeavoring to do every day in trying to get productive results from a team of many nationalities working in one building is, in miniature, what must eventually be accomplished on a world-wide scale. If this sounds fantastic and unrealistic, I ask you to consider whether there is in fact any alternative. As scientists and educators, you must accept the responsibilities which the interdependence of nations have brought to your doorstep.

The EUSEC Report on Engineering Education and Training in Western Europe and the United States

THORNDIKE SAVILLE

Dean Emeritus, College of Engineering, New York University, and Consulting Engineer. Recently Director of Science and Engineering Center Study, University of Florida

By the time that this article appears in print, there should be available the three-volume report on Engineering Education and Training in the Countries of Western Europe and the United States of America. This report is the most exhaustive comparative study of engineering education in different countries which has yet been undertaken, and it should be of interest to both engineering educators and practicing engineers in the U.S.A. It is the purpose of this article to describe briefly the development, scope, and contents of the study. The major portion of the article is taken from the Introduction to the report, prepared by the writer as chairman of the committee charged with the conduct of the undertaking.

Historical Resume

At the second Conference of the Engineering Societies of Western Europe and the United States (EUSEC) held at The Hague in September 1951, a recommendation was made that procedures be established to facilitate the interchange of views on the various methods followed in the countries of the participating societies for the education and training of engineers. This recommendation was adopted by the EUSEC societies, and implemented by three conferences held respectively in London (January 1953), Zurich (September 1954), and Paris (September 1957). Official delegates to the conferences consisted of three representatives from each society, composed of a member of the teaching profession, an industrialist or practicing engineer interested in engineering education, and a representative (usually an officer) of the society. The conferences included also such unofficial participants as any delegation desired to bring because of special knowledge or interest. Eleven countries were represented at each of the three conferences as follows: London, 32 representatives; Zurich, 37 representatives; and Paris, 48 representatives and 14 observers.

Preparation for the Paris Conference involved assignment to six General Reporters, from five countries, of responsibility for preparation of a report on a special topic. Each general reporter undertook to explore by means of questionnaires and correspondence the subject of his assignment with designated groups in each of the EUSEC countries. The subjects and the reporters were:

1. *Diagrams and Glossary.* To describe the situation respecting technical education in each country by a number of diagrams pertaining to the structures of the educational system (block diagrams) and to the number of persons educated (flow diagrams) with appropriate explanatory text. A glossary defines the terms used in the diagrams and other significant terms of educational import. Report prepared by

A. W. J. Mayer of Holland.

2. *General Education before Admission to Engineering Schools of University Level.* To summarize for each country the academic qualifications required for entry upon an engineering education, the subjects constituting the preparatory curriculum, and the allocation of time during the final two years of preparatory school given to mathematics, physics, chemistry, and general subjects. Included also was a description of the methods and criteria used by engineering colleges for admission of students. Report prepared by Willis Jackson of the United Kingdom.
3. *Education at Engineering Schools of University Level.* An analysis of the reports from each country with respect to duration and content of the several engineering curricula, the nature of the examinations given, the method of teaching, the composition of the teaching staff, the failure rate of students, and the nature of any associated industrial training. Report prepared by Willis Jackson of the United Kingdom.
4. *Practical Training of Engineers, Before, During, and After Their College Studies.* An analysis of the various systems in effect in the respective countries, and their effect upon the education and training of engineers. Report prepared by H. Mayer of Switzerland.
5. *Post First-Degree Education.* A description of the methods and objectives of formal education subsequent to receipt of the first academic degree. Report prepared by Oskar Akerman of Sweden.
6. *Criteria for Professional Recognition.* A description of procedures in effect in the respective countries, both by custom and by law, to protect the practice of engineering and to accord professional recognition to engineers. Report prepared by Thorndike Saville of the United States.

The Proceedings of the Paris Conference (1957) contain the reports and the discussions upon them, as published by the Institution of Mechanical Engineers of Great Britain. The compete responses of their respective countries to each of the conference topics were separately published by the engineering societies of Belgium, the United Kingdom, and the United States.

The Paris conferees were so heartened by the significance of the material assembled, that they recommended to EUSEC that the report of the conference be considered of a preliminary nature, and that EUSEC take steps to amplify and complete it in the form of a truly comprehensive document. EUSEC adopted this recommendation at its meeting in New York in April 1958, and established a Committee on Engineering Education and Training, to be assisted by two Working Parties; one for the diagrams and glossary, and the other for the remaining subjects and for the preparation of a general report. These groups were composed in general of persons who had attended the three conferences. They had established friendly relations, and had become accustomed to working with each other over a period of eight years.

Financing and Organizing the Study

Experience with assembling material for the Paris Conference for only some of the EUSEC countries indicated clearly that a comprehensive comparative report covering engineering education and training in all 15 (in 1961, 16) countries represented in the EUSEC membership would require financial support. The Working Parties would require staff assistance, and there would be costs for necessary meetings and for publication. EUSEC authorized the solicitation of funds to assure the conduct of the undertaking. Accordingly approaches were made through the European EUSEC Societies for contributions from those societies or national agencies in their countries. The EUSEC Secretariat in New York approached the Ford Foundation and the Organization for European Economic Cooperation for assistance. Prompt interest resulted, and assurances were ob-

tained of sufficient funds to hold a meeting of the Committee and Working Parties at The Hague in April 1959. At that time a detailed program of procedure was developed as follows:

Phase 1. Each of the comprehensive National Reports from Belgium, the United Kingdom, and the United States of America prepared for the Paris Conference was to be reviewed by a competent assessor recommended by the Working Parties. Three assessors were authorized, who would determine revisions necessary to produce reasonably standardized and comparative reports to serve as models for all of the countries to be included in the study. An outline for a model National Report, approved by the Working Parties, was to be prepared and sent to National Reporters for each country.

Phase 2. National Reporters were to be appointed for each country, to prepare a National Report conforming to the outline. These reporters were to be persons particularly qualified to describe the system of engineering education and training for the country.

Phase 3. Assessors were to be appointed to review and edit the National Reports to assure their conformity to the outline and standards promulgated under Phase 1.

Phase 4. The Working Parties would prepare a final report from the revised National Reports of Phase 3. Working Party I would be responsible for a section on diagrams and glossary, and Working Party II for a general report covering the other elements considered at the Paris Conference and enumerated at the beginning of this paper.

A major policy was adopted, and rigorously adhered to throughout the study, whereby emphasis was to be placed upon descriptions and comparisons of the several systems of engineering education and training, with careful avoidance of any evaluations of the relative merits of the systems. It is hoped that any reader will be able to make his own evaluations from the material contained in the report.

The Committee at the meetings at The Hague in April 1959 developed a budget totaling $60,000 regarded as necessary to conduct the program as outlined and to deliver a report to the EUSEC meeting in Brussels in August 1960. The budget was larger than that originally contemplated for a survey of the EUSEC countries only, since OEEC had indicated that if it made a contribution it would desire a coverage of *all* of the OEEC countries, several of which did not have national societies as members of EUSEC.

Contributions sufficient to underwrite the budget were received from the Ford Foundation, the Organization for European Economic Cooperation, and through the engineering societies of Western Europe. In spite of the short time for the conduct of such an undertaking, and the initial delays consequent upon financing, a report in English was delivered to EUSEC in 1960 as contemplated. Authorization for publication was received and the substantial task of editing and printing the three-volume reports, one set in English and one set in French, has required another year.

The National Reports

The National Reports contain a vast amount of data never before assembled dealing with the system of engineering education and training in each country. The material in the present report to EUSEC necessarily contains only a small fraction of the extensive data to be found in the National Reports, the preparation of which has in fact represented the most difficult and expensive part of the entire enterprise. Because of the volume and cost of reproduction of these reports, only enough copies were prepared for the use of the assessors, Working Parties, and Committee. However, the National Reports contain much information which should be of great value not only to the countries with which they deal, but to other countries as well. The Committee recommended strongly to EUSEC that it urge its constituent national societies, and indeed national societies and other agencies in non-EUSEC countries, to exercise every effort to have the National Report for that country reproduced for general distribution. There are constant requests from one national society to another, or

from one governmental agency to another, for detailed expositions of the system of engineering education and training in effect. Availability of the National Reports for exchange purposes and to meet the requests for information which can be obtained readily only from these National Reports will serve many purposes which cannot be met fully from the necessarily abbreviated descriptions in the present report. The National Report for the U.S.A. will be published by ECPD.

National Reports, from which the information in the final Committee Report has been assembled, were received from the following countries:

Countries Represented in EUSEC

Austria	Italy
Belgium	Norway
Denmark	Spain
Finland	Sweden
France	Switzerland
West Germany	United Kingdom
Holland	United States of America

Countries Represented by OEEC but not in EUSEC

Greece	Ireland*
Iceland	Luxembourg
	Turkey

Organization of Report

Volume I of the Report deals mainly with a general description of the system of education, at all levels, for each of the several countries. Thus for each country there are the following: (i) a general statement of the system of education, (ii) a block diagram with explanatory notes, and (iii) a flow diagram, also with explanatory notes. These appear in the alphabetical order of countries.

For purposes of readily comparing the systems of education in the different countries, the report utilizes the concept of "levels," based generally on nominal age groups. The first level period is approximately from 6 to 12 years of age; the second level is from 12 to 18 years of age; and the third level is from 18 years of age onward.

*Now represented in EUSEC

The block diagrams indicate the various routes of engineering and technical education from the last year of the first level up to the end of the third level education when the first degree is usually received. The diagrams show various aspects of the alternative routes which students follow toward particular educational objectives. The flow diagrams show the relative numbers of students following the different educational routes based upon 100,000 leaving first level education.

Volume II of the Report is a comparative study of engineering education and training in the EUSEC and OEEC countries and deals more specifically with second-level and third-level education; practical training; post first-degree education and criteria for professional recognition.

Volume III of the Report is a glossary of terms used in the various National Reports. Where it has been necessary to use national terms in the text of Volumes I and II the words are underlined and, for a definition or explanation of such a term, the reader is referred to the glossary of terms.

This glossary should be of great interest to engineering educators and practicing engineers, quite apart from its relation to the report itself. Many terms used in literature from foreign countries and in describing the qualifications of professional engineers are quite misleading if given a literal translation. The definitions in the glossary, both in the English and French editions, are given in sufficient detail to render an adequate understanding of the true meaning of the terms.

Objectives of Present Report

The present report represents the first attempt at collaboration between the engineering societies of Western Europe and the United States of America to present a comprehensive, accurate, and objective comparison of the national systems of engineering education and training in these countries. The differences in educational and professional philosophies,

as well as language, have made this effort extremely difficult. Nothing like it has been undertaken before. The greatest obstacle was the procurement of competent National Reporters, who would devote the considerable amount of time required to fulfill their tasks. Inevitably the National Reports, and hence the material abstracted from them in the present report, represent unequal levels of attainment. This has been further complicated by limitations on both money and time. Nonetheless, this report is a pioneering effort which it is hoped will mark a significant beginning toward consummation of the objectives which the Committee set for itself. These are to:

1. Enhance the understanding among engineers of the Western World of the education of engineers in each of the countries.

2. Describe processes of engineering education in one or more countries which may advantageously be adopted or modified for use in other countries.

3. Assist in validating the qualifications of engineering graduates of one country for post-graduate education or professional practice in other countries.

4. Promote comity among the engineers of the Western World, and elsewhere. Engineering is worldwide and international in character, and increased understanding among engineers will be conducive to increased collaboration among peaceful peoples everywhere in activities designed to produce greater prosperity and higher standards of living.

The Committee realizes that this first undertaking of its kind presents less than a fully comprehensive account of the systems of engineering education and training in all of the countries involved. It welcomes comments and criticisms, particularly as it is charged by EUSEC to "keep the matter of engineering education under review."

Acknowledgments

The EUSEC Committee on Engineering Education and Training was charged with the organization and conduct of the study. It consisted of M. Edmond Hianné (Belgium), Sir Willis Jackson (United Kingdom), Professor F. M. Roeterink (Holland), Mr. W. H. Wisely, Secretary, (U.S.A.), and Dr. Thorndike Saville, Chairman (U.S.A.).

To assist the Committee EUSEC established two Working Parties responsible in general terms for the diagrams and glossary and the General Report, respectively. Working Party I consisted of Dr. Henry H. Armsby (U.S.A.), Professor Maurice Derron (Switzerland), Mr. F. H. Reid (United Kingdom), Ir. J. Ligthart, Secretary (Holland), and Dr. Ir. A. W. J. Meyer, Chairman (Holland). Working Party II consisted of Mr. Oskar Akerman (Sweden), Professor M. Louis Baes (Belgium), Dr. Harold Hazen (U.S.A.), Dr. Ing. Dino Zambetti (Italy), Mr. Brian G. Robbins, Secretary (United Kingdom), and Mr. F. E. Sleight, Chairman (United Kingdom).

The truly international composition of the Committee and Working Parties is evident. All members devoted much time and thought to the project, which they gladly donated in the interest of its accomplishment.

The original draft of the report was in English. The task of editing it for publication, and particularly the preparation and editing of a French version, was considerable. The difficulties consequent upon a great variety of specialized national terms used throughout the report in describing the educational processes in different countries made most time consuming the accurate rendition of the meaning of such terms in the glossary, both in English and in French. This task was superbly accomplished by an Editorial Working Party consisting of M. Edmond Hianné (Belgium), Mr. Brian G. Robbins (United Kingdom), and Ir. J. Ligthart, Chairman (Holland).

There were 19 National Reporters, 5 assessors, and several staff assistants who participated significantly in the work connected with the study. A complete list of all persons contributing in a major way to the undertaking is given in the report.

The report will be distributed in the United States by the American Society of Civil Engineers, which has acted as treas-

urer during the conduct of the study. The three volumes of the report are entitled respectively: *A Description of the Systems of Engineering Education and Training in the EUSEC and OEEC Countries; A Comparative Study of Engineering Education and Training in the EUSEC and OEEC Countries;* and *A Glossary of Terms Used in Engineering Education and Training in the EUSEC and OEEC Countries.* A nominal price of $3.00 has been established for the three-volume set in the hope of ensuring a wide distribution.

INTEGRATED CURRICULUM AT BROWN

Engineering students at Brown University will be able to earn the bachelor of science and master of science degrees in their field in five years under a new integrated curriculum that went into effect this fall.

Under the curriculum in effect until now, one and a half to two years of work above the undergraduate level have generally been required to attain the master of science degree in engineering, according to Professor Paul S. Symonds, division chairman.

The new program is designed to attract students of high ability whose immediate interests tend towards applied research and advanced design and development, as distinguished from the doctoral program, which is designed for students pointing towards a career in basic research and teaching in engineering science.

"The program for the Sc.M. is intended to be different from that for the Ph.D. in the extent of training but not in the quality of work or of student," Professor Symonds said. "There is a real national need for more people with training afforded by a high level Sc.M. program in engineering. Such training provides a bridge from developments in research in the engineering sciences to the solutions of problems of modern advanced technology."

The main effect of the new integrated program is to make it possible for selected Brown undergraduates to complete a program leading to the master's degree in five years without sacrifice of the previous high quality.

The decision to enter the integrated Sc.B.-Sc.M. program will be made tentatively at the start of the sophomore or junior year, and definitely at the start of the senior year. The student in his fifth year will be enrolled in the Graduate School and eligible for the regular fellowship aid available at that level.

If for any reason a student should decide to stop at the end of the fourth year, there would be no penalty involved, since he would by then have completed all requirements for the Sc.B. degree.

In his senior year, the student will spend time equivalent to one or two courses on an independent research or design project, with supervision by a faculty advisor. He will continue this project through his fifth year and write a thesis describing it.

One effect of the new program, Professor Symonds said, should be to attract into graduate study a higher proportion of Brown's qualified undergraduates in engineering. There will be no effect, he said, on the Sc.M. or Ph.D. programs of students who come to Brown from other colleges and universities. Of the Brown undergraduates who enter the integrated program there will undoubtedly be some who become attracted into a doctoral program.

Engineering Education in Indonesia

DOEDI SOEMAWIDJAJA

Educational and Cultural Counselor of the Indonesian Embassy in Washington, D. C.

I hope that my speech will be able to give our distinguished audience a brief picture of the problems in the field of education, particularly, in the education of engineers, faced by the people of Indonesia, who number about 93 million, and that it may bring about an understanding of a people, who, since their independence 15 years ago, are struggling with their utmost effort for progress in all fields of endeavor.

It is generally true, that colonizing countries do not pay attention to education for the natives, for good education would become a great disadvantage to the colonizers.

Education and instruction were merely given to produce certain personnel that were profitable to capital invested in their colonies. It is not surprising then that in Indonesia, which had been under the Dutch domination since the 17th century, a technical school of university level for the education of future engineers was not established until 1920.

Other schools of higher learning established in Indonesia before our independence in 1945, were the School of Law in Djakarta, 1924, and the School of Medicine, in the same city in 1927. The total students enrolled in three schools in 1936 was only 1000.

Similarly, the economic structure was arranged in such a way that only those materials were produced which could be sold by the colonial power at large profits in the world market. To enforce compulsory crop cultivation, laws were enacted under the name of "Cultuur Stelsel" in Indonesia in the 19th century.

The colonies, at the same time, were also fertile territories to become markets for goods manufactured by the colonizing countries. In short, these were the conditions in the colonies, because of the lack of concern on the part of the colonizer to provide education and instruction for the subject people.

During the Dutch period about 93 per cent of the Indonesian people did not know how to read and write. This problem of illiteracy existed not only in Indonesia but in other colonized countries as well. It is no wonder that there is currently a very great thirst for learning and for rapid progress in these newly independent countries of Asia and Africa.

Young nations fully realize that the building of states must be carried out through education that is in harmony

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with the needs and ideas of their people. We are aware that with the right kind of education man can be brought closer to his natural resources. The ability to exploit these resources and to bring prosperity to the people can only be achieved through education.

The development of education in my country, including education for engineers, cannot be separated from the history of education in the colonial period. To give you a closer picture of this development and to be able to give an evaluation of our engineering education, I should like to present the following figures on education at the end of the Dutch regime and the 1960 figures for comparison:

	1942	1960
Elementary Schools Students	2.4 million (most 3-years course)	8 million (all 6-year course)
Secondary School Students	less than 50,000	800,000
College Students (faculties)	1,800	45,000 (ten universities)
Illiteracy	93%	50%
Population	around 75 million	90 million

From these figures, one may conclude that higher learning was sadly neglected. There was not a single complete university for the then population of about 75 million, except only a Technical Faculty in Bandung, which produced civil engineers; one Law School (faculty) and one Medical School in Djakarta. Indonesia at that time had only 200 civil engineers and 20 agricultural engineers. It can also be added that there were only ten economists and two Indonesian professors in the whole of Indonesia.

For a country which produced so much wealth from oil, tin, coal, and other natural resources, as well as agricultural products for the world market, such as rubber, tea, coffee, tobacco, kapok, spices and copra, it is easy to see that it is ridiculous, indeed, to have such a small number of engineers.

It can also be added, that there is still so much to be explored in the field of mining in other regions of Indonesia, which will certainly open up new sources of wealth and income which will enrich the country even more than ever before.

The extension of territory of exploitation and the intensification in the method of work need to be carried out, to enable further increase of yield, not only in quantity, but also in quality.

The Indonesian government is currently busily engaged in building up the country, based upon the Overall Construction Pattern prepared by National Planning Bureau, and which has been approved by the Peoples Council (Parliament) *Madjelis Permusjawatan Rakjat* at the end of 1960.

In this framework many of our students are being sent abroad to study in various sciences to help carry out the task of overall construction upon their return to Indonesia.

During the colonial period the great emphasis was upon what is called *algemeen vormend onderwys* (general education) "to know something about everything." For a newly independent country like Indonesia, possessing such great natural wealth, the emphasis should be on technical education. The people of Indonesia who live amidst an ideal environment with fertile soil, great wealth of natural resources, seas rich in marine life, will remain poor if they do not have the training to exploit these riches for home as well as foreign consumption.

We are fully aware that the skill and ability to exploit wealth must be attained through specialized education, particularly engineering education at university level. For this reason, the Department of Basic Education and Culture has established a separate section which administers specialized studies, and a separate department called "Department of Higher Learning and Science."

Technical Engineering School

Let us look at the development of the

Technical Engineering School in Indonesia. During the First World War, in the Dutch period, the business enterprises in Indonesia, which were entirely in the hands of foreigners, faced the danger of having their supply of technicians severed from their sources in Europe. This brought about a feeling of uncertainty among the entrepreneurs, and pressed by conditions of the time, they realized the necessity for having a technical engineering school in Indonesia, to meet their need for technicians in case their relations with Europe were broken.

As an initial step toward this goal, these entrepreneurs formed a committee to organize *Koninklyk Instituut voor Hooger Technisch Onderwys* (Royal Institute for Higher Technical Education) at the beginning of 1917, and an Educational Advisory Council was formed in the same year to formulate an educational plan for the technical engineering school.

The Advisory Council decided that the program of study at the technical engineering school would require four years. The opening of the School was set for 1922, and it was decided to establish the school in Bandung (West Java) under the name of *Technische Hogeschool*, a private school, but enjoying government subsidy. The diplomas were to be of equal rating with diplomas from the *Technische Hogeschool* in Delft (Holland).

On July 3, 1920, the *Technische Hogeschool* was officially opened in Bandung, two years ahead of schedule. For the time being this school offered only courses in road and water-system construction (civil engineering), while a curriculum in chemical engineering remained in the planning stage.

Thus, a quarter of a century before Indonesia's independence, the people of Indonesia were introduced to the first school of higher learning which was to produce engineers.

Unfortunately, due to the very high cost of tuition, the great majority of our people could not afford to send their children to this school. The number of students enrolled at the opening was 28, with a teaching staff of 6 professors and teaching assistants. In 1924, this school turned out 12 engineers. In the same year the school was turned over to the Netherlands East Indies government.

By the end of 1935, the following teaching facilities were available:

1. Natural Science Laboratory
2. Hydraulics Laboratory
3. Hydro Electro (Central) Laboratory
4. Technical Mechanic Laboratory
5. Transportation Engineering Laboratory
6. Soil Mechanics Laboratory
7. Sanitary Engineering Laboratory

In 1940 and 1941, the divisions of Chemical Engineering and Mechanical Engineering were added respectively. At the outbreak of war in the Pacific, the Technical School had produced 213 civil engineers. The war and consequently the Japanese occupation from 1942-1945 gravely hindered the school's growth.

With the fall of Holland and prior to the outbreak of war in the Pacific the Dutch professors were conscripted into the Dutch military service, so that the students were left on their own. With anticipated disruption, movable teaching and laboratory equipment were put away for safekeeping, some of them with staff members.

Under the Japanese

After the Japanese forces entered the city of Bandung, they converted the school building into their military headquarters. Several months later at the request of the Dutch professors and coinciding with the Japanese military's interest, the laboratories were reopened under the auspices of the "Institute of Tropical Sciences."

For the Dutch professors, the reopening of the laboratories meant postponement of their commitment into internment camps, aside from the opportunity for them to continue research which they had started before the war. In the end, however, they too were interned.

As a continuation of the Institute of

Tropical Sciences and as an attempt to win the hearts of the Indonesian people, especially to regain their trust which had worn thin among the Indonesian intelligentsia, the Japanese military government reopened the Technical Engineering School on April 1, 1944, and for the first time since the colonial government, it bore an Indonesian name, *Sekolah Teknik Tinggi.*

The School offered a three-year course in the following fields: 1. civil engineering, 2. chemical engineering, and 3. electrical mechanical engineering.

Enrollment of new students was limited to a maximum of 30, plus the acceptance of old *Technische Hogeschool* students. During the Dutch regime, the Technical Engineering School was under the charge of a Dutchman; whereas, during the Japanese occupation its director and a majority of the teaching staff were Japanese. Here again, for the first time, Indonesian teachers were given the opportunity to be included on the teaching staff. The Japanese professors taught in Japanese and used English when necessary to give additional explanation.

The Indonesian teachers were allowed to conduct instructions in Bahasa Indonesia, the national language, for the very first time since the Dutch colonization some 350 years ago.

The students, aside from receiving training in technical sciences, were also taught the Japanese language, military science and the spirit of nationalism. The library was stocked with books in Japanese. During the Japanese occupation five civil engineers were graduated. (The Japanese phase of the Technical Engineering School ended with the proclamation of Indonesian independence on August 17, 1945).

After Indonesian Independence

After the proclamation of independence the school reopened under the same name, *Sekolah Teknik Tinggi,* as it was named during the Japanese occupation, under the directorship of Professor Engineer Rooseno, an Indonesian. In view of conditions at that time, it was not possible for students to devote full-time to their studies. Students, in general, took up arms for the defense of the newly independent state, so that courses could not be given in an organized manner.

As a result of the Dutch military advances in several areas of Indonesia, Professor Rooseno and his Indonesian staff moved from Bandung to Jogjakarta in Central Java in November 1945, where the Technical Engineering School opened for instruction in the middle of 1946, and were able to offer a four-year program in civil engineering. The courses in mechanical/electrical and chemical engineering could only be completed up to propaedeutic II level. In 1947, many of the mechanical and chemical engineering students with Propaedentic II diplomas were sent to India to finish their education. The school in Jogjakarta was closed again due to the second Dutch military action in December 1948.

After the transfer of sovereignty from the Dutch at the end of 1949, the Technical Engineering School in Jogjakarta was reopened again but offered only civil engineering. Students who were formerly enrolled in mechanical and chemical engineering were permitted to continue their studies at the faculty of Technical Sciences in Bandung which had reopened under the Dutch when they reoccupied the city of Bandung.

The Technical Engineering School which was set up in Jogjakarta by a core of Indonesian teachers from Bandung, became the Technical Faculty of Gadjah Mada University when the university was officially inaugurated as a State University in August 1950.

Aside from the Technical Engineering School, whose history continued in Jogjakarta, the Dutch regime revived the school in Bundung and made it a part of a university named *nooduniversiteit* (emergency university) as a faculty of Technical Sciences. This again was renamed University of Indonesia in March 1947, as the Faculty of Technical Sciences, which included civil, chemical and mechanical engineering divisions.

The course of study was five years to parallel that of the Technical Engineering

School in Delft, Holland, in order to guarantee the continuity of study for students from other divisions whose studies could not be completed at the Faculty of Technical Sciences in Bandung.

In the beginning, the courses in mining and electrical engineering in Bandung were available only for the first two years, and it was necessary to complete the study at the Technical Engineering School in Delft, Holland.

The system of tests used at that time was conducted through examinations held at the end of each academic year, for diplomas in the following consecutive order:

P 1. (propaedeutic, part I); P 2. (propaedeutic, part II); C 1. (candidate, part I); C 2. (candidate, part II) and the engineer's diploma.

With the transfer of sovereignty the leadership of existing universities and institutions was turned over to Indonesia. However, in the early stages, Dutch teaching staff was retained because of the necessity for the functioning of the Technical Faculty, and this was set forth in a Cultural Co-operation clause in the agreement of the Round-Table Conference with the Dutch Government.

The process of Indonesianization of this faculty which was necessary in order to guarantee its national character was not a simple matter, especially since the number of Indonesian staff was small.

At the time of its opening the *Technische Hogeschool* had only a Division for Road and Water Construction (civil engineering). Today, the Technical Faculty has expanded to include the following divisions:

1. Road and Water Construction (civil engineering);
2. Chemical Engineering;
3. Mining Engineering;
4. Electrical Engineering;
5. Mechanical Engineering;
6. Engineering Physics;
7. Geodesy;
8. Architecture and Plastic Arts.

In order to be able to have a complete picture of their development let us view each division separately: The Division of Road and Water Construction (civil engineering) is the oldest division of the Technical Faculty in Bandung.

Civil Engineering

The program of study for civil engineers, according to the new schedule, takes four years, or eight semesters. In the fifth semester students are permitted to choose between two fields: one, specializing in studies dealing with water, such as canals, irrigation, bridges and dams; and the other dealing with land which includes soil mechanics, construction and maintenance of buildings, resource development, etc.

The division of civil engineering has at its disposal the use of five laboratories: 1. mechanics laboratory, 2. structural models laboratory, 3. irrigation laboratory, 4. soil mechanics laboratory, 5. hydraulics laboratory.

Approximately 4000 books and 1000 magazines comprise the library.

Chemical Engineering

The purpose of the chemical engineering program is to produce capable technicians to develop to its fullest capacity the great abundance of our natural resources for increased prosperity. These technicians can be of great service to our industries, research foundations, Government agencies and in the field of education.

The chemical engineering division has seven laboratories: 1. physical chemistry/basic laboratory, 2. analytical/inorganic chemistry laboratory, 3. microbiology laboratory, 4. organic chemistry laboratory, 5. unit operations/process laboratory, 6. chemical engineering laboratory, 7. special technology laboratory.

Its library has about 1000 books/titles and some 5000 magazines.

Mechanical Engineering

The mechanical engineering program requires four and one-half years. The first two years are for courses in exact and natural sciences and technical sciences, which are basic requirements for engine construction which is given intensively in

the third year. In the fourth year, there is specialization with a choice of one major and two elective subjects.

The mechanical engineering division has one engine laboratorium and a machine shop. It has a library of approximately 1500 books.

Electrical Engineering

The program of study for electrical engineers is four years. In the first two years, subjects are taught which will serve as a foundation for the remaining two years, in order that the students may have a good basic background. In the last two years, students are given systematic explanation regarding electrical engineering science. At the beginning of the second half of the course, the student decides on his major field, whether he should specialize in: a. the field of electrical power techniques; or, b. the field of telecommunication techniques.

The electrical engineering division has an electric power house laboratory and a library of about 2500 books plus approximately 750 magazines.

Mining Engineering

The duty of a mining engineer is to make available the minerals which are present in Indonesian *soil* for the use of mankind, and if necessary to change these to *materials* for consumption. The mining engineering program is a four-year course. At the end of the first two years the student can take a complete preparatory examination. After the completion of this examination, he has a choice of pursuing either: a. the field of exploration, or b. the field of general mining techniques.

Engineering Physics

Engineering physics has the following laboratories: 1. electricity measurements, 2. electron optics, 3. electronics, 4. atomic physics, and 5. laboratory for physics of continuum.

Aside from these laboratories, the engineering physics division also has workshops for glass-blowing and for making instruments. To carry out further research in scientific developments, it has plans for additional laboratories for acoustics, illumination, heat transfer, pure physics, cosmic rays, and X-ray. The Engineering Physics Library includes some 2400 books and 67 magazines for resources.

An engineering physics diploma is given after successful completion of the following examinations:

1. Preparatory examination (divided into two parts: the first part is given at the end of the first year, and the second part at the end of the second year).
2. Candidate examination is held at the end of third year.
3. Engineer's examination.

Aside from training future physicists, it also trains metrologists, who have in the past few years taken an important role in the industries in Indonesia.

There are plans for training nuclear engineers, as soon as facilities and equipment for laboratory and research can be made available for instruction.

Geodesy

Although this division has made progress from its early stages, it is still far behind in the matter of equipment, when compared to the rapid advances made in the field of geodesy in other countries. The geodetic engineering program is a five-year curriculum. Its library has around 1500 books.

Architecture and Plastic Arts

The division of architecture and plastic arts is divided into two sections, the plastic arts section and a section for architecture.

The plastic arts section is concerned with providing theoretical knowledge and technical know-how, aside from developing the aesthetics and creative expressions of the student. In all courses the essence of artistic problems is emphasized in order to open ways of action and encouragement, to instil in students the will to work in the direction of scientific knowledge and artistic expression. Programs of study in plastic arts may be selected from the

following fields: a. painting art, b. sculpture, c. decorative or art design, d. graphical and illustrative art, e. plastic arts education.

A student is free to choose from the different offerings or on the advice of his counselor, in accordance with the student's ability. There is an examination at the end of each academic year, the last of which is at the end of the fourth year. The plastic arts section has a library of about 3000 books and 80 different magazines.

The curriculum for an architectural engineer requires five years of study. It is divided into three parts. The first part requires two years of basic preparation. The second part, also of two years, deals with actual courses in architecture, while the third part, which lasts for a year, is reserved fully for planning of important constructions in their chosen field of specialization. A student may select from one of the following specializations: 1. utilities structures, 2. monumental architecture, 3. housing or city planning.

Aside from the libraries in these divisions, there is also a Central Library comprised of 38,000 books and more than 1000 different scientific magazines.

Obstacles to Development

When one follows the foregoing explanation with regard to the development of various divisions in the Technical Faculty, one may easily get the impression that we did not encounter any difficulties. The truth is that there were many difficulties we had to encounter, so much so that they were obstacles which hindered our educational development.

The appointment of an Indonesian, Professor Soetedjo, as director of the Technical Faculty for the academic year 1953-1954, represented an important step toward the Indonesianization of the Technical Faculty.

In 1950, the number of Dutch professors exceeded the number of their Indonesian counterparts, but gradually the Dutch professors were replaced by professors from other countries. At the same time, we were sending our students abroad who would be members of the teaching staff after completion of their study and return to Indonesia. The plans for recruitment of foreign teachers on individual contract basis encountered several difficulties. Aside from the time-consuming procedures, there was no certainty that the continuity of studies could be maintained for the students. The sending abroad of future teachers, however, could not be expected to bring results within a short period.

Therefore, in order to avoid these difficulties and to expand and improve our facilities as well as curriculum, an affiliation program between the Technical Faculty and the University of Kentucky was initiated in July 1956. With the establishment of this affiliation, a Kentucky Contract Team was sent to Bandung to assist in the teaching at the Technical Faculty, and to assist the Faculty with laboratory equipment, books and other educational materials. The professors from the Kentucky Team taught at the Faculty, with Indonesian professors as their counterpart.

Whenever necessary, because of the lack of sufficient Indonesian professors, an affiliation professor was appointed head of a division. Mutual understanding and appreciation between the affiliation professors and their Indonesian counterparts were essential requisites for maximum results.

But this affiliation will not continue forever, so that every effort must be made in order that, at its termination, the Technical Faculty will be able to stand on its own feet without the assistance of foreign professors. Another fact which gave rise to many difficulties in the development of the Technical Faculty was the increasing number of students, which was out of proportion with the facilities available, and which overloaded the teaching ability and capacity.

In this connection, it can be stated that the number of students has multiplied about ten times during the years between 1950 and 1960. Therefore, it has been necessary since 1955 to use a system of entrance examination for admission to the Technical Faculty.

Still another difficulty faced by our students was in the language. Formerly, between 1949 and 1952, courses were given mainly in Dutch and in Indonesian, whereas they were now given in Indonesian and in English.

In the beginning, the courses in English met with difficulties, but fortunately, these difficulties were gradually overcome. At the same time, there were changes in the libraries, for textbooks in Dutch had to be changed to English textbooks.

This is the story of the development of the Technical Faculty in Bandung, the oldest school of higher learning in Indonesia. I would like to add here, that since the beginning of 1959, this Technical Faculty has merged with the Faculty of Exact and Natural Sciences into a separate institution, and has since been named the "Institute of Technology" at Bandung. The Institute of Technology has the status of a university and has three departments:

1. Department of Technology
2. Department of Exact and Natural Sciences
3. Department of Chemistry/Biology

Through its three departments, the purpose of the Institute of Technology is to train engineers who are urgently needed for service in the national reconstruction.

In closing, may I, on behalf of my people and government, take this opportunity to express my thanks and appreciation to the government of the United States and to the University of Kentucky, and to many private organizations for their assistance to us in the field of higher education.

I feel that such programs are most desirable and useful for the progress of our country and people. More important, I feel that such programs are gestures of your friendship and good will.

ENGINEERING EDUCATORS FAVOR CHANGES IN CURRICULUM

A majority of the nation's civil engineering educators favors major changes in engineering education, including a pre-engineering program and extending the total period of education, according to the American Society of Civil Engineers.

The opinion of the educators was obtained in a mail ballot conducted by the Society. Results were analyzed by ASCE's Committee on Engineering Education, assisted by a special advisory group representing other engineering agencies concerned with engineering education.

Balloting of the educators followed the 1960 Conference on Civil Engineering Education, held at the University of Michigan, Ann Arbor, to which official delegates from 140 schools with accredited curricula in civil engineering were invited. The educators voted on resolutions, all related to improvement in engineering education, which had been presented at the Ann Arbor meeting.

Among the conclusions reached after a study of the ballots were the following:

1. That there is an overwhelming sentiment for promoting the growth of graduate study in civil engineering and for the establishment of graduate professional schools of engineering.

2. That a majority is in favor of moving toward a pre-engineering program and in favor of extending the total period of education.

3. That an overwhelming majority is in favor of raising the standards of performance and ethics in the profession by taking a firm stand on these matters through the American Society of Civil Engineers and Engineers' Council for Professional Development, and in favor of taking an articulate position on the importance of basic scientific and cultural subjects.

Opportunities in World Food Production, Processing, and Distribution

FRANK J. WELCH

Assistant Secretary,
U. S. Department of Agriculture

The entire history of civilization has been one of recurring famine. The certainty of three meals a day has *never* been the rule, but the exception to the rule.

Even now, the inhabitants of two-thirds of the globe live in poverty with not enough food to sustain physical and mental vitality or even to keep alive the hopes of a better life.

But at the same time that so many people are malnourished or hungry, a segment of the world's population—for the first time in history—has freed itself of the fear of famine. American agriculture has demonstrated to the world a capacity to produce and distribute on a year-round basis enough food of good quality to meet the nutritional needs of every man, woman, and child in this country, and still have abundant supplies left over to feed a hungry world.

This is one of the most significant breakthroughs in human history. We have shown—through our amazing productivity –that science combined with great determination and effort *can* wipe out hunger, famine, and disease, and allow people *everywhere* the opportunity to fulfill their individual destinies.

We can now envision freedom from hunger as not only a practical possibility, but a needed practical *objective* for all the world. I say this with the full realization of the enormous problems involved. The fulfillment of this age-old dream will involve the application of science and technology on a worldwide scale.

The remarkable success story of our own agriculture is largely the result of applying science and technology through every discipline related to agriculture.

Certainly one of the most important has been the progressive multiplication of man's energies through advances in agricultural engineering. Man's output of roughly one-twentieth of a horsepower is barely enough to perform the smallest agricultural operation. But when man learned to harness his mind instead of his body and turned out mechanized equipment to do his work for him, he unleashed a major worldwide revolution. And ever since, agricultural engineering and the many disciplines making up agriculture have been discovering, inventing, and developing ways to improve our farming efficiency and increase our agricultural productivity.

In 1940, the American farmer produced enough food and fiber to support himself and 10 others. Today, he produces enough for himself and 24 others. He has nearly *tripled* his output of work in 20 years.

Furthermore, our record levels of food and fiber production today are being forged by a steadily decreasing percentage of our total population. Less than nine per cent of our people now live on farms. And between 8 and 10 per cent of our total labor force is employed in agriculture.

Presented before Agricultural Engineering Division of the American Society for Engineering Education, Lexington, Ky., June 30, 1961.

This means, then, that one-third *fewer* farmers produce food and fiber for one-third *more* people than 20 years ago. *Never* have so few farmers fed so many consumers so well, as in our nation today.

By way of contrast, 45 per cent of the Soviet labor force is employed in agriculture. One Soviet farmer can produce enough food and fiber to feed himself and between four and five others.

Over 70 per cent of India's labor force is required to meet the nation's food and fiber needs. And in terms of efficiency, one Indian farmer produces enough for himself and between three and four others. Diets, however, are not adequate.

In Poland, about 40 per cent of the people still work in various farming enterprises, and one Polish farmer provides enough for himself and between five and six others. Colombia, a relatively undeveloped but rapidly developing nation, numbers over 50 per cent of its labor force in agriculture. And a farmer in that country can produce enough to feed about five others besides himself.

The newly developing nations of Africa represent a somewhat harsher picture. The vast majority of that continent's 250 million people are now and will continue for some time to be engaged in agriculture. Nigeria—one of the biggest, best-developed, and most populous African nations—still shows 80 per cent of its people in agricultural pursuits.

The real test of agricultural productivity lies in the food-buying power of the consumers in terms of real wages. And here in America, our agricultural successes have mostly benefited the consumer. He can buy a year-round nutritious and varied diet for himself and his family for about one-fifth his take-home pay—working fewer hours than in any other country. Furthermore, he's spending two per cent *less* today for food than in 1939, and he's eating better than he was then.

Few of us appreciate this kind of productivity until we see how consumers in other nations fare. It's common in most countries for people to spend a third to a half or even more of their incomes for food. The people of Nigeria, for example, spend roughly three-quarters of their income for food; India, over 60 per cent; Poland, 50 per cent; Colombia, between 40 and 45 per cent. The French spend about 35 per cent of their incomes for food; the Italians, over 45 per cent.

I emphasize these contrasts to show the contributions of our agricultural productivity and its potential to the world. Some of this potential is already being realized in our food assistance and technical training programs. As you know, our agricultural abundance has been shared by many nations to prevent hunger, malnutrition, or famine.

The Long View

Unfortunately, there are many areas in the world where food and fiber are chronically lacking in various degrees either in quality or quantity, or both. This makes it imperative that we approach our food assistance programs from a long view . . . from a broad, *worldwide* standpoint. We must do *more* than meet emergency food deficits as they occur throughout the world. We must help the world's agriculture provide enough nourishing food for all nations everywhere, within the limitations imposed by culture, tradition, and needs.

We must first learn more about foreign needs.

One highly important step in this direction has already been taken. The first overall picture of world food problems has been developed by a special task force of experts in the field of international food and agriculture.

Such worldwide food shortages are extremely difficult to measure quantitatively. But it *is* possible to express the nutritional value of the foods people eat in terms of our agricultural production.

Thus, in this highly simplified but useful way, we find that the estimated world food shortage for 1962 is roughly equivalent to 35 per cent of our annual milk production . . . plus 40 per cent of our annual dry bean and pea production . . . plus 120 per cent of our annual wheat production.

The world will *not* automatically eliminate its food deficit by producing these amounts of food. The figures simply give a rough idea of the dimensions of the world food shortage.

Total calories and total proteins—especially animal protein— are very low for populations of Western Asia, Africa, the Far East, Mainland China, and large parts of Latin America. The effect of such shortages is to make the populations more vulnerable to certain deficiency diseases, and to reduce the vitality and energy that is necessary for national development.

Where we can, we share our agricultural abundance fully. We also share our technical knowledge to help nations help themselves. With these approaches, we're making progress in closing the world food gap, despite the enormous educational, sociological, and economic barriers standing in the way.

Our Food for Peace program to distribute our agricultural abundance wherever human needs exist is a basic approach that can help foster good will, good health, and economic progress. Various governments and many private agencies are participating to make this a great push forward to alleviate the miseries brought on by malnutrition or hunger.

More than 1,000 American technicians are now working in newly developing nations throughout the world, translating agricultural science into better living for millions.

Thousands of agricultural visitors from other countries come here to study our agricultural research and education, and our food production and distribution methods, in the hopes that similar techniques can be applied to their countries.

Many voluntary organizations, other industrialized nations, and several agencies of the United Nations contribute in effective worldwide programs to lift the threat of hunger.

Producing Stable Economies

Again, as part of our plan to help other nations improve their agriculture, we're working to improve their systems of food production and distribution. The ultimate challenge will *not* be how much food we can give to other nations. Rather, it will be in the success of our attempts to help other nations achieve a stable economy based on a prosperous agriculture. This is a difficult task that calls for an integrated approach.

It is not enough, for example, to establish irrigation projects and other isolated farm development projects. We also need disease-resistant, specialized crops tailored for the local environment. We need soil fertilization and pesticides. We need machinery to harvest the crops. We need to have a continuing supply of fuel for machines, and the men with the knowledge to service them. We need the means to move crops to market—highways, railways, harbors, airports, trucks, airplanes. We need power. We need storage facilities. We need effective and reliable distribution channels and people who will consume or use the product in some way. And above all, we need some form of stable government that can insure continuity of farming operation.

This kind of integrated approach means, of course, that scientific agriculture will have to find its setting in an industrial economy—exactly as it has in this country. We've already made a start in this direction in some countries.

In assisting other nations, we cannot always transfer technology from one country to another and expect it to work. Full account must be taken of the conditions in the country where the technology was developed and in the country to which it is transferred. A good recommendation for using lime in one country, for example, may be ruinous in another with different soils and crops.

Then, too, the use of one technique depends upon the availability of others. For example, skill in handling machinery and electric power is vital to modern-day farming operations. But such skill is lacking in most undeveloped countries. In these areas, farmers must progress from hand tools to simple tractors to tractor-drawn machines with as few adjustments as possible.

The Need for Understanding

In our overall struggle to provide food for the world's population, we must also include comparable efforts to broaden and deepen man's understanding. Ultimate success in any program for long-range agricultural improvement depends upon combining advances in the agricultural sciences along with advances in the social sciences and humanities.

In fact, the educational, sociological, and economic barriers standing in the way of developing an efficient agriculture in the world may be more difficult to overcome than the scientific and technological problems.

Thus, as we win the worldwide battle with hunger, we will at the same time and as part of the same effort win the goal of social progress.

Certainly a large share of our success in meeting these goals will lie in the field of agricultural engineering, since nearly all farming operations involve engineering applications for greatest economy and effectiveness.

How can agricultural engineering meet the new problems in agriculture . . . problems created by advancing technology, increasing population, and the rising hopes of people everywhere?

Worldwide, we will need more energy and new forms of energy in the years ahead. Dwindling coal and oil supplies, rising population, and growing worldwide demands for more consumer goods may soon make such needs increasingly urgent.

Immense possibilities exist in the fields of solar and nuclear energy. A farm tractor powered by fusion atomic energy has already been mentioned as a possibility. I believe that we can find practical and economical ways to use both forms of energy in producing and processing agricultural commodities.

Engineering research can show us how to use the many new plastics, metals, and alloys to improve our agricultural machines and equipment . . . how to better utilize new liquid, solid, and gas chemicals for greatest effectiveness for insect, disease, and weed control . . . how to reshape land and rechannel water for highest agricultural productivity.

You in engineering research can improve the rural industries and services that upgrade agricultural commodities and build markets. You can develop low-cost machinery and equipment for profitable farming systems in mountainous and other depressed areas. You can design flexible farm structures and processing plants as a step in farm and plant automation.

Overall, I believe agricultural engineering research will have to dig deeper into basic research to solve the engineering problems facing farmers. This type of approach provides the starting point for most of the scientific advances made in agriculture and elsewhere. It offers the greatest challenge and the greatest promise in the world today. It offers the hope of modeling the physical world to our desires.

But there also exist great opportunities in adapting known techniques in assisting undeveloped countries. The field is wide open and the prospects are bright.

We in the West have tended to regard the Malthusian theory as somewhat impractical in our pragmatic world. But the universal tendency of population to outrun the means of subsistence—as Malthus theorized—has already become a reality in some parts of the world.

World population is expected to reach the 6 billion mark before the end of this century. That's double the present figure.

We have no alternative but to apply our technical and scientific knowledge on a vast scale to insure adequate world food supplies. Agricultural engineering will have the continuing task of providing much of the physical basis for worldwide progress.

Briefly, we *do* have the natural and scientific resources to feed the world now and for some years to come. But we face a tremendous challenge in fulfilling current needs and anticipating the future. There will be no room here for the "conventional wisdom" that Professor Galbraith speaks of. We will have to work in *uncharted* areas and deal with *new* ideas and *new* concepts. Success will come as we apply the energy, will, and vision to do the job.

Results of the Revisions of Engineering Curricula Since the 1955 Evaluation Report

NEWMAN A. HALL

Chairman of Mechanical Engineering, Yale University and Vice President of ASEE for Instructional Divisions

As one looks back over the history of engineering education in this country, there are many events which marked turning points in the constantly evolving trends. ASEE has played a major role in these events over the years. The most recent of these was the publication of the *Report on the Evaluation of Engineering Education* in 1955. This report, the product of a committee effort chaired by L. E. Grinter, has had an impact that is still hard to assess fully. Of similar studies over the years, its significance has been greatly enhanced by its close association with ECPD accreditation. Following the war and the resumption of the active accreditation program, it became apparent that the criteria available were inadequate to cope with the rapidly changing picture. Consequently the study was undertaken to provide a basis for establishing improved criteria and its findings have been used very specifically in the subsequent administration of accreditation operations.

It has been my pleasure, or perhaps my burden, to have spanned, in service to ECPD, the period since the appearance of the Grinter report, so there have been many diverse opportunities to observe its impact on our educational operations.

I should like to draw on this experience to make a number of observations and to draw a few conclusions regarding the trends that have developed and the problems that have arisen and have yet to be resolved as a consequence of this evaluation study. It is not my intention to burden you with statistics or involved curricular analyses. I am not sure but that such details might confuse the clarity of the broad features in which I am interested. Furthermore, there have already appeared a number of analyses of curricular trends which present facts and figures. The most recent of these is a study by Henry H. Armsby, Chief for Engineering Education of the U. S. Department of Health, Education & Welfare entitled "Trends in Engineering Education—1949 to 1959," appearing as Office of Education Circular 635. I recommend this carefully assembled report for your thorough examination.

Before making any observations I believe an important preliminary remark is in order. I suggest that the Grinter report is always well worth rereading. There is much of long-lasting value to be found in it, and a reexamination may easily reveal that its breadth can serve to guide on many points beyond those which have received most attention. In many ways its timeliness is still as great as ever.

Presented at the ASEE Annual Meeting, June, 1961. Recommended for publication by the Relations with Industry Division.

From Specific to Fundamental

Now what are some of the major observations which may be made regarding changes in the engineering curricula resulting from the *Evaluation Report*? First and foremost has been a shift from the specific to the general and fundamental and to the concepts that encompass broad classes of engineering systems from the techniques of the engineering art to the methodology of approach to engineering problems.

The genius of the American engineer has been his emphasis on making things work. Our educational traditions have always been primarily concerned with training an engineer to be able to produce usable results efficiently and effectively. As new products and processes have been developed, our engineering education has steadily adapted and improved its program so these changes could be accommodated. This realization of the importance of constant revision has been a principal motivating consideration in the series of major studies of engineering education which culminated in the Grinter report. The *Evaluation Report*, differing from its predecessors, made quite clear that engineering education would no longer be guided solely by the need for understanding engineering procedures relevant to established devices, processes, and practices. The pace of change had accelerated so greatly that no existing practice could adequately illustrate or even anticipate the tasks the young engineer would be called upon to perform.

Thus it is that established procedural skills have taken a second place to the acquisition of an understanding of the general method and approach of engineering to wholly unanticipated problems. It has become more important to be familiar with the most fundamental and far-reaching technological and scientific resources than to be able to carry through personally all the steps of the engineering operations. This shift had already begun many years ago, for at one time not only did the engineer design, and often fabricate his devices, but operated them in service as well. Our lay terminology unfortunately too clearly reminds us of this earlier practice.

It is true of course that established practice will provide the best source to illustrate the ways in which the engineering method has been applied effectively, and familiarity with the engineering works of the past provides a powerful motivation for the engineering student. Yet this information has its primary value as illustration and inspiration. As the engineer constantly makes his former products obsolete with his new designs, so must the educator recognize however, that the specific illustration will often be obsolete by the time it is used.

The Engineering Sciences

To accommodate this broad change in emphasis the most important shift in the engineering curricula has been the rise of the engineering sciences. This has become the focal area within the undergraduate curriculum. There has been and will be much development in establishing just what the engineering sciences include, but there is no question that they must be central in the training of the engineer who will participate in the development and research activities of the future.

At the same time there has been a substantial reduction in emphasis on techniques and skills. For example, while the use of graphical representations will always be an essential means of communication, of presentation of information, and of analysis for the engineer, there is no longer a need for his being trained as a skilled draftsman. Similarly, the engineer who is concerned with the production of machines need not be a skilled machinist. These and other similar cases are very familiar and while the change is in this direction, its full implication is not yet clear.

A major recommendation of the *Evaluation Report* involved an increase in the emphasis on general education. In response to a clearly expressed concern of industry it had become evident that a wider base of preparation in humanities and social sciences was essential for the

engineer whose responsibilities so often exceeded a rigidly circumscribed technical activity. This recommendation, as elaborated by subsequent ASEE studies, has had a very significant effect on most engineering curricula. It has not always been easy to plan this area of the curriculum since it must involve collaboration between the engineering and liberal arts faculties. Many different resolutions of the problem have appeared which express the diverse character of various institutions.

Analysis and Design

Probably one of the most significant changes which has occurred has been in the area of engineering analysis and design. *The Evaluation Report* gave major stress to the importance of this portion of the curriculum. Yet the effect and to some degree the wording of the report was negative. The engineering schools have indeed tended to eliminate courses which relied on standard procedures or were merely descriptive. However, this remains one of the areas of confusion. It appears that a major portion of the former engineering curricula patterns has been weakened and even though a constructive step forward was encouraged, this has proved to be the most difficult task to work out. It is doubtful if more than a small minority of schools are at all satisfied with their total progress in this regard. In certain fields, such as electrical engineering and metallurgy, it is frequently difficult to find any courses which are exclusively concerned with design in a traditional sense even though engineering analysis may be very extensively developed. In the fields of power or structures there are constant efforts made to revise or develop new approaches to teaching design. It would appear almost that the abstract concept of design methodology in many cases was more than our engineering faculties were willing to accept.

As a final observation it has become clear that within the compass of a four-year curriculum all the desirable objectives of engineering education are not going to be met. Each school selects its own pattern of compromise and it is not difficult to establish feasible bases for judging whether a minimum level of accomplishment has been reached. But there is a general belief that as our sights have been raised higher, we must be prepared ultimately for some more extensive engineering educational program. Any institution must be satisfied with the services it provides, and this will not be true if there is a conviction that the job is incomplete.

Thus in spite of the real forward step which the *Evaluation Report* provided, there remain and have developed some very real problems. In addition to those which I have inferred already, there are some others which current efforts in curriculum development constantly reveal.

One of the immediate reactions to the Grinter report was an uncertainty regarding what should be included in these new emphases on the engineering sciences as well as engineering analysis and design. Recognizing this problem there was immediately established a follow-up committee which in 1958 issued a report on these fields which endeavored to clear away the uncertainty. This has been useful but only partly successful. In many cases today, the courses identified as engineering science represent not much more than a reorganization, merely omitting description and analyses of specific engineering systems and devices. The great lack of usable source material has limited an effective advance in providing a truly comprehensive and flexible foundation in applied science. It is not sufficient to select a text from a newly designated engineering science series or to group together those courses in this category which seem a little more general and less specifically usable than others. A constant intensive study and reexamination of diverse source material must be carried on to realize at all adequately the potentialities of the engineering science emphasis as well as to secure adequate coordination with the basic sciences.

Similarly in analysis and design, there has been a tendency merely to remove some of the older and more familiar de-

vices and systems and to resort to a more abstract and purely analytical examination of classes of devices. There are few design texts which adequately present the approach which the *Evaluation Report* recommended. It is fairly clear that this calls for an unusual degree of design experience and imagination on the part of the instructor as well as a much greater effort to introduce varied examples and projects illustrating the broad uses of design methodology. The task of the engineering faculties is more difficult today but the guidance and source material is still seriously limited.

In the instrumentation of the *Evaluation Report* much has been stated regarding the desirability of constructive experimentation as well as the intrinsic nature of the recommendations in allowing creative flexibility in curriculum development. A careful study will confirm the validity of this position. Yet the most frequently heard criticism of the accreditation criteria derived from the report is that they impose an undue degree of regimentation. I believe that this apparent contradictory situation arises from the following factors. First, a satisfying interpretation of the recommendations of the *Evaluation Report* within a four year undergraduate program requires both an unusual degree of academic and practical engineering competence within the faculty together with a sympathetic acceptance of the spirit of the report. There is a particular premium on curriculum efficiency which, while of course desirable, is not always attainable. Second, it is difficult to introduce new faculty into an effective appreciation of the particular combination of science and engineering that is encouraged. If the individual is not trained to an advanced degree in applied science, this aspect of the curriculum may escape him almost entirely. On the other hand many of our current doctoral graduates in engineering are so limited in practical engineering experience that their easiest path is to ignore the full potentialities of the design emphasis. Third, the development of source material that fully represents the spirit of the Grinter report has lagged seriously behind the efforts to put the recommendations into practice. And last, it requires an unusually fortunate freedom for creative faculty endeavor to depart constructively from a fairly rigid interpretation of the suggested curriculum pattern.

These difficulties were anticipated, of course, in the *Evaluation Report* itself, which gave an unusual emphasis on the importance of faculty development. This has subsequently been given further attention in recent ASEE studies. Yet the difficulties persist and an adequate solution has not appeared.

A further problem arises from the question whether the *Evaluation Report* adequately reflects the broad complexities of the team effort which the profession of engineering must represent. It is very uncertain whether it is wise to conceive of the responsibility of the engineer as limited to any one level of the total activity with which he is in contact or to provide an education which directs him primarily toward only one of several possible goals. At the time of writing the *Evaluation Report* it was certainly clear that the greatest need was a major expansion in the number and quality of engineers prepared for research and development. The strong emphasis on engineering science was particularly appropriate to this need. Current thinking in this direction is stressing the desirability of graduate work for this aspect of engineering and one might conclude that all engineering may be steadily moving towards the graduate level.

As a contrast, however, to the emphasis on the research and development engineer, more recently substantial attention has been given to the role of the technician as a member of the engineering team and to the problems associated with his education. It is significant that this aspect of engineering education was not mentioned by the Grinter report.

In between these two bounds there are many tasks and activities that contribute to the total engineering effort. Perhaps there are additional intermediate goals in engineering practice and education which should be stated clearly and constructively. Perhaps there are institutions which

will never move in the direction of graduate studies and for whom consequent dominant emphasis on engineering science may not represent their best service to the student and the profession.

This is by no means a suggestion that we could be complacent in any case with an obsolete or mediocre representation of engineering endeavor. There is no level of the engineering profession which can remain satisfied with the status quo. I suggest merely that a broader look at the diversity of the engineering profession may provide a basis for a more satisfying program of constructive service for a number of our engineering schools.

We should also recognize that the motivating factors for the engineering student run the whole gamut from the technician to the research scientist. Our ability to command the enthusiasm and ability of the student will be measured by the diversity and intensity of the opportunities we provide for him.

The *Evaluation Report* represents a milestone in our constant endeavor to move forward in engineering education. The response of our engineering schools is a measure of the sincere desire to accept constructive advances. Let us recognize that its full value is yet to be realized. But let us also search for the broadest aspects of our responsibilities as engineering educators and be prepared to meet them with creative imagination and ideas with acceptance of the ultimate task of the engineer to put things into practice.

Leeds and Northrup Fellowships Awarded

Four outstanding graduate students in engineering will receive support next year under a fellowship program administered by the American Society for Engineering Education for the Leeds and Northrup Foundation.

Three new fellowships awarded for next year will go to:

Richard D. Chelikowsky, who plans to enter studies for a master's degree in electrical engineering at Kansas State University next fall.

Carl H. Harmsen, who will study mechanical engineering at the University of Wisconsin next fall for a master's degree.

Jay S. Marks, who will enter doctorate work in chemical engineering at the University of Kansas next September.

In addition, a fellowship award to William D. Stanley, who is studying for a doctor's degree in electrical engineering at North Carolina State College, has been renewed for the coming year.

The four fellowships were awarded at the Annual Meeting in Lexington by Dr. Ralph A. Morgen, president of Rose Polytechnic Institute and chairman of ASEE's industrial fellowship committee.

The fellowships, Dr. Morgen said, "emphasize industry's increasing stake in graduate engineering education. The growing complexity of many technological fields on which industry is dependent dictates increasing reliance on engineers trained at greater depth and breadth. Industrial fellowships are planned to increase the supply of well-trained men for industry—and also to increase the supply of engineering teachers of high quality, thus providing still more highly trained graduates in the future."

Are We Educating Scientists or Engineers?

MERRITT A. WILLIAMSON

Dean, College of Engineering and Architecture
The Pennsylvania State University
University Park, Pennsylvania

First of all, I think that we ought to take a hard and critical look at what is meant by the term "engineering." The applicability of Lewis Carroll's *Alice in Wonderland* and *Through the Looking Glass* seems to increase daily. Sometimes I think that engineering educators have not only fallen down the rabbit hole but also have gone through the mirror into a strange territory where everything has a logic, but which is contrary to what we define as normal.

For a point of departure into this strange land, let us examine what engineering is. I have heard it stated that engineering is changing. I think this is erroneous and misleading. Engineering is not changing. What is taught in engineering colleges is, however, changing. The type of work that engineering college graduates do when they enter industry is changing. I believe that what is defined by industry as engineering work is changing. It seems to me as I talk with people about engineering and engineering education that there are an inordinate number of Humpty-Dumpties. You will remember that Humpty-Dumpty said to Alice, "When I use a word, it means just what I choose it to mean—neither more or less." I think this is a source of much trouble.

At the risk of being labeled a reactionary, a fuddy-duddy, and unprogressive or what have you, I submit that we have a perfectly good definition of engineering in every state in the Union. I do not see anyone attempting to change the legislation although this may come about one of these days. The definition does vary somewhat from state to state, but all of the different definitions conform quite closely to what is set forth in the Model Law of 1946. I should like to read the definition emphasizing certain words that are used to characterize engineering:

> The term "Practice of Engineering" within the meaning and intent of this Act shall mean any *professional* service or *creative* work requiring engineering *education*, *training*, and *experience* and the *application* of special knowledge of the mathematical, physical, and engineering sciences to such professional services or creative work as consultation, investigation, evaluation, planning, design, and supervision of construction for the purpose of assuring compliance with specifications and design, in connection with any public or private utilities, structures, buildings, machines, equipment, processes, works or projects.

The key words are *professional*, *creative*, *education*, *training*, *experience*, and *application*. Looking ahead to the future, I believe that regardless of how technology may change, there will always be a need for the practice of engineering as defined above. I think these are the important terms which distinguish the engineer from his technological brothers, the scientist and the technician. The scien-

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tist to my mind should emphasize the creative and the technician should emphasize the application, but only the engineer is really charged with creative application. Engineers, to my mind, are truly innovators and directors, but they are applicators as well. I do not want to dismiss either the scientist or the technician lightly. Both are capital fellows, indeed, and I number many friends among them. Long may they live! The world needs their services! In fact, the world needs them so much and the products of our engineering colleges are so promising and so well prepared that they are readily welcomed into the folds of both. Let me make one thing clear. Their work *is* important; the jobs which they do *are* important; engineering leans heavily on both and, in fact, should give direction to and lead both; but the bald faced face is that many graduates of engineering colleges are not practicing engineering as it is defined legally. I fear that in some curriculums within engineering colleges, the students are not being trained to become engineers at all although they are awarded a degree in engineering. You will note that I used the phrases "graduates of engineering colleges" and "students trained to become engineers." Graduates of engineering colleges are not immediately engineers upon graduation—they are potential engineers only. They have not yet practiced engineering and are not yet engineers.

With the advent of a more complicated technology, pioneered probably in the fields of aeronautics and electronics, there is greater need for a deeper understanding of fundamental physics and mathematics than was necessary twenty years ago. Faculties of science and specifically departments of physics have not produced enough graduates to fill the real need for persons of high scientific skill, ingenuity, and imagination to carry out research in these areas. In my opinion, nuclear physics and solid state physics have held the alluring spotlight in the realm of science. Since classical physics has been relegated to a back seat, what well trained persons could be enticed and intrigued into the realms of research in hydrodynamics, aerodynamics, thermodynamics, electronics, etc.? From the time that they first entered industry many engineering graduates have been in research operations doing highly significant and important work, but how many have conceived of themselves as practitioners of a profession? How many have been involved in evaluation, planning, design and supervision of construction to insure specification and design compliance? After five years in industry, how many are capable of producing any evidence of professional engineering practice?

Since there is a ready market for college graduates to enter these fields, and since their training for these jobs can be improved by the inclusion of more advanced courses in physics and mathematics, there is being exerted constant pressure on colleges to changes their curriculums to meet this demand. Where such pressures have shaped curriculums, some men have been graduated who are sadly lacking in engineering "know-how," engineering attitude, and engineering professionalism. Since they graduated from engineering colleges, these men assume that they are engineers. When they talk on engineering education they advocate educating "engineers of a changed variety." I think that colleges and universities must fill the need for research scientists. This is important, but for heaven's sake, let's put the proper label on them and let's not misguidedly change our curriculums so that we cease to graduate anyone capable of handling an engineering job!

Know-how and Know-why

Engineering must concern itself with utility and application, "know-how" if you will. Engineering is not primarily a search for new fundamental knowledge and "know-why." The engineer also has to have some competence in the area of "know-whether." The knowledge of "whether to" or "whether not to" is of vast importance and the engineer, as a professional, recognizes his obligations to society and his obligations to adhere to

the ethical standards which are set forth in his canons. His is a professional responsibility. A man, regardless of how brilliant or how well trained scientifically he may be, is no engineer in my book if professional responsibility isn't always a consideration in everything that he does. The "know-why," which is, of course, important, has its direct impact on society or civilization only through the "know-how" of the engineer.

Should we teach the know-how in college? There are those who claim that anything smacking of practical work should be eliminated. Practical work is dismissed glibly by saying that this can be picked up later on. Certainly it can and it must be; but I think we have to teach some of this, or we are not orienting our students to the full scope of engineering practice. What is picked up later from industry may be woefully incomplete. There are important elements of art still remaining in many engineering fields, although I must concede that in aeronautics and electronics, the art phase now appears more in the realm of the technician.

To my mind, the problems of highly deductive science which lend themselves to mathematical analysis are much simpler really than are the problems in other areas of engineering such as industrial engineering and civil engineering for example. Far from being backward as some would have us believe, these areas involve complex decisions which have heavy human impact; for example, organized unions, management hierarchies, seniority, guaranteed wage, labor legislation, sociological impact of automation, morale, etc., to cite but a few problems in industrial engineering. Or the condemnation of citizens' homes, the location or relocation of thorofares in a politically charged environment, public reactions to the location of sewage treatment plants with resultant property deterioration, legal codes which may have been outmoded. Truly, civil engineers cope with such problems daily and their decisions directly affect life, health, property, public welfare. It would be so nice to have a Maxwell's equation, a Bernoulli's theorem, or a Prandtl's theory to apply, but where human beings are involved, a solution arrived at in an aggregate or statistical mechanics sense fails miserably when applied since individual, highly vocal units are involved. The rights of citizens and the dignity of human beings have to be considered. Engineering, since it is defined as a profession, must be intimately concerned with all of this. The patient scientist in his laboratory seeking a research result is spared these considerations. The technician, too, bears no responsibility, since the engineer for whom he works assumes the professional obligation. Individually, the scientist or the technician may assume a concern, but my point is that it is not demanded by his colleagues, and he will not be barred from practice if he chooses to forget all about it.

By now you can gather that I am concerned about the future of engineering education. If our graduates, who are loosely called engineers, (but who are accurately termed potential engineers as I have stated earlier)—if our graduates enter non-engineering work (that is, work not covered by the legally accepted definitions of engineering), and if they, in turn, demand more persons from our colleges who are better prepared for that type of work, then there is a real concern that if we are not careful very few, if any, engineers will be graduated. This to my way of thinking would be a serious matter.

The Future

Now, what about the future of engineering education? We are living in an era where just to be liberally educated, one must have a knowledge of science which is far deeper than what was taught twenty years ago in our liberal arts curriculum. Similarly there is no denying the need for deeper study and more profound understanding of mathematics, physics and the underlying engineering sciences: mechanics of solids, fluid mechanics, thermodynamics, rate and transfer mechanisms, electrical theory, and the

nature and properties of materials. Our graduates of the future ideally should have broader knowledge and greater depth. I fear, if we are not careful, that our curriculums can become so crowded in trying to provide technical breadth, that they may well produce a superficial person. I do not view with alarm specialization in some one narrow engineering field. There should be some depth in education. The methodology of acquiring essential information can only be usefully taught using specific applications as examples. In cramming our curriculums we must be careful not to sacrifice professional awareness. We must prepare our students to know how to tackle new fields that will arise in the future. We must be sure that they are not superficial. Engineers have got to be able to talk to scientists and to comprehend their results in terms of application within an economic framework. Economy is the constant companion of the engineer whose job was quite well defined seventy-three years ago by A. M. Wellington as "the art of doing that well with one dollar which any bungler can do with two after a fashion."

We have got to prepare our engineers to be able to carry out engineering jobs of the future. The technological basis for their work may not have been developed at the time they leave school. Isn't the important thing, then, to teach the engineering approach—the method of getting on top of new situations, through self study of new areas with understanding, the instilling of a practical curiosity so that, regardless of how intriguing or how socially superior research may appear, there will always be those persons, namely the engineers, who can affect society through application? Isn't it also important for industry to expect to send their engineers back to school to take the refresher courses which the universities must be prepared to offer?

My warnings: beware an overemphasis on factual information in all the latest areas of technology. Beware such breadth in fundamentals and in "know-why" that a man never learns anything in depth, and has no idea how to apply new knowledge through people in solving socially important problems, because he has never learned any "engineering." The teaching of engineering cannot be left to post-baccalaureate work unless every graduate school in the country changes its philosophy. Graduate schools are the stronghold of scientific research. Practice, know-how, empiricism are not profound in an academic, scholarly sense and are not generally tolerated as suitable areas of advanced study.

The scientist, oriented toward research, poses for himself problems in terms of which he has the necessary methods for analysis and solution. The engineer is not so fortunate since his problems are thrust up from the real world. He has to solve those that exist—not those that are hypothesized and lend themselves neatly to solution. I am not decrying this latter approach since it is necessary to point the way. The problems, however, are not engineering problems. I have an uneasy feeling that the swing to a heavily scientifically-oriented curriculum has resulted from a parallel type of thinking in which the problem is conceived of and redefined so it can be solved. It is very difficult to get persons as staff members who have theoretical understanding blended with experience in practice and a good, sound, scholarly, high level intellectual approach. It is not nearly as difficult to find an experienced brilliant young man with a good command of mathematics and a keen analytical approach as it is to find an engineering practitioner oriented to the field of education. Since the problem of finding an ideal engineering teacher is so difficult, why not dismiss that problem by pretending that the real problem is to give the students more and more "fundamentals" of science and mathematics? If this outlook is declared loudly and repeated often enough one comes to accept this as both a mark of progress and an inevitable trend.

It is to be expected that this outlook, which is produced from avoiding the real problems, will be much more prevalent on campuses than in industry, because the

whole academic environment glorifies the intellectual advance and scholarly profoundness. Our graduate schools help to foster this since they are most reluctant to recognize outstanding competence as a practicing engineer as any qualification for a faculty member, unless somewhere along the line there are publications. Publications really are an abstraction from the solid world of accomplishment. No wonder publications have little appeal to the practicing engineer. Look at the disdain with which "practical" problems are regarded as thesis and dissertation subjects.

It is easier, therefore, to redefine our educational needs so that they can be met by getting bright young men on the faculty who are scientifically oriented and who have never practiced. They may serve as consultants, it is true. Consultation, however, is no substitute for shouldering the responsibility for engineering decisions which are based on many unknowns and require the judicious application of calculated risks and the factors of safety. These are an intimate part of the vocabulary of the engineer. When confronted with a problem, the scientist by temperament and training will go back to the lab, research the Hell out of it, and come up with a very accurate answer one or two years later. These answers are important. They help the engineer in his later designs, but they do not ever keep him from taking engineering risks. If there are no complex risks, then no engineer is needed.

I just hope we are always aware that we can, in our educational institutions, perform the job that gratifies *us* by assuming that all undergraduates must receive a broad background and by assuming that they will go on to graduate school to become further enamored of books, mathematical analysis and all the rest. The question I would submit to you for careful thought is this, "Are our graduates being really educated and trained, if you will, for the real engineering jobs which exist now and will continue to exist in the real world of the future?" I am under the impression that the graduates from the curriculums in many of our so-called engineering institutions are not now being so prepared.

My plea, then, to education is to teach *engineering*, to teach the art, the economics, the social-humanistic courses, the design know-how, the technology, the professional awareness. True competence in engineering comes from practice. My plea to industry, then, is to use engineers for engineering work, to give them professional status, to have adequate numbers of scientists and technicians to stretch the capabilities of engineers to perform.

By way of summary, I think that I discern four outstanding trends in engineering education:

1) A shift toward science with which I am in agreement unless it results in neglect of training in application which, to me, is the essence of engineering.

2) A shift toward breadth in scientific fundamentals. I agree that this is desirable, but not to the point of doing away with undergraduate specialization in presently recognized fields of engineering. This, I fear, will produce superficiality. Parenthetically, "Be narrow enough to be deep!" For the engineer, it is not enough to know *why*; he must *produce*, not talk and write about producing!

3) A shift away from professionalism, and social responsibility. (I hope I am wrong on this trend, but you can only cram so much into a curriculum!)

4) The development of a "pecking order," with the highly deductive, mathematically, based, heavily research-conscious engineering areas pecking the inductive, empirical, more socially-conscious engineering areas. With this trend I am certainly not in sympathy. Where is there any authority for such an ordering of professions unless it be in some academic presupposition which derives from an overglorification of mathematics?

To return to the theme, "Are We Educating Scientists or Engineers?" If "we" mean the engineering colleges, I believe the answer is that we are educating both. Society needs both. However, I think we, the engineering educators, should be vi-

tally concerned that we are not derelict in turning out students who are imaginative, but practical, and also sensitive to persons through whom engineering efforts come into reality. Let us not, with all the magic surrounding the words *science, research,* high powered *mathematical analysis* and so on, shove into the background of our thinking the concepts that go along with *application, utility, economy,* and *professionalism,* for these latter are the essence of engineering design and there is nothing old-fashioned, out-dated, or sub-intellectual about them. Much as we need the boys on cloud nine, no type of educational institution other than ours is ever going to produce the highly intelligent, highly devoted, highly cost conscious, truly professional person that society needs. We must not fail to meet this obligation by taking any easy ways out!

NUCLEAR SUMMER INSTITUTES FOR 1962

Summer institutes on nuclear energy sponsored by the American Society for Engineering Education and the Atomic Energy Commission have been offered since 1955 and will again be offered in 1962. Specific information will be sent to deans and department heads as soon as proposals are approved, probably by November 1.

Three Different Types of Institutes to be Offered

Three different and distinct types of programs are proposed for 1962. The "special topics" institutes are designed to present topics in newly developing areas of nuclear engineering and engineering education in nuclear energy. These programs are to bring together faculty members from colleges and universities having well-established nuclear engineering programs who are teaching nuclear engineering courses and who are interested in developing additional research and teaching abilities.

A second group of advanced summer institutes is for "experienced" teachers in nuclear engineering who wish to further develop their abilities in and knowledge of established areas of nuclear engineering. An experienced teacher is one who has, by virtue of formal education or equivalent work experience, a sound background in nuclear phenomena and who is teaching or developing nuclear engineering courses. Those having the common responsibility of developing and teaching nuclear engineering courses will find these institutes of particular value.

The third type of institute proposed for 1962 is an "orientation" institute for engineering college and technical institute faculties. This new program is primarily for members of other departments such as mechanical engineering, electrical engineering, metallurgy, physics and mathematics. This orientation institute will provide the teacher with a knowledge of nuclear engineering and science as it is related to his own field. The first part of the eight-week program will cover basic concepts of nuclear physics and nuclear energy systems. The latter part of the institute will be divided into two or more parallel programs in suitable special fields of study concerning actual current design problems in which nuclear phenomena are involved. The "basic" course, offered in the past to get people interested in the nuclear area with the idea that they transfer their interests and teaching, no longer will be offered.

Application forms for the 1962 Summer Institutes on Nuclear Energy will be available after November 1 from your dean or department head or directly from the American Society for Engineering Education, University of Illinois, Urbana, Illinois. Applications will be reviewed and applicants will be notified of acceptance in February.

Why Some College Freshmen Chose Engineering

W. P. ANGERS
Assistant Director

F. N. ENTWISLE
Director Emeritus

A. P. JOHNSON
Director
Counseling Center, Newark College of Engineering

Anyone who followed the fall 1960 session of the United Nations General Assembly is well aware that we are living in an age of technology. For those who are engaged in educational-vocational guidance and counseling, there is a vital relation between present world affairs and the need for engineers.

We were very much interested in knowing some of the factors that contribute to the choice of engineering as a career in order that we may better identify,[1] understand, and serve pre-engineering and/or engineering students. A questionnaire entitled "Why Did You Choose Engineering?" was devised by us to further this purpose.

This questionnaire was administered in mid-September 1960 to 480 entering freshmen[2] at the Newark College of Engineering, a city- and state-supported urban college to which its students commute. The questionnaire consisted of some thirty items with five choices to permit replies on an IBM answer sheet. On the set of directions each student was instructed that there were no right or wrong answers and to mark the choice which was true for him. If he was unable to make one choice, he might then mark two or more choices.

A tabulation of replies for the entire class resulted in the following information:

1. About how long ago did you first decide to study engineering?
   1. More than 4 years ago—(24%)
   2. From 3 to 4 years ago—(26%)
   3. From 2 to 3 years ago—(26%)
   4. From 1 to 2 years ago—(21%)
   5. Less than a year ago—(3%)
2. Who or what first got you interested in studying engineering?
   1. A parent, relative or friend—(34%)
   2. A teacher, principal or counselor—(19%)
   3. A TV or radio program—(4%)
   4. Some reading—(21%)
   5. Some other experience—(22%)
3. If a parent, relative or friend got you interested in studying engineering it was (out of 248 replies)

[1] A. P. Johnson, "Identifying Prospective Engineering Students," a paper read at the October 26, 1960, guidance symposium, "Engineering in the Sixties," sponsored by the New Jersey Engineers' Committee for Student Guidance at the Bell Telephone Laboratories, Murray Hill, New Jersey: a report to New Jersey guidance counselors, parents and prospective students on the changing pattern of admission standards among engineering colleges in New Jersey.

[2] F. A. Grammer and W. A. Newman, "The Admission Picture at Newark College of Engineering for Entering Freshmen in 1960," a class characteristics study, Admissions Office, Newark College of Engineering, Newark 2, New Jersey. This study shows distributions of ranks in high school class and College Entrance Examination Board scores for this entering class.

1. Your father—(111 instances)
2. Your mother—(22 instances)
3. An older friend—(35 instances)
4. A friend of your own age—(23 instances)
5. A relative—(57 instances)

4. If a teacher, principal or counselor first interested you in studying engineering, it was (out of 130 replies)
   1. A science teacher—(42 instances)
   2. A mathematics teacher—(38 instances)
   3. A guidance counselor—(31 instances)
   4. A principal—(8 instances)
   5. Another teacher—(11 instances)

5. If it was a TV or radio program, it was (out of 43 replies)
   1. A newscast—(1 instance)
   2. A special report or documentary—(15 instances)
   3. A regular science program (Mr. Wizard, etc.)—(14 instances)
   4. The Continental Classroom in chemistry or physics—(8 instances)
   5. Some other—(5 instances)

6. If it was some reading, it was (out of 165 replies)
   1. A vocational pamphlet in (or out of) the school counselor's office—(53 instances)
   2. A science fiction (or phantasy) story or magazine—(16 instances)
   3. An engineering society pamphlet—(17 instances)
   4. A book—(53 instances)
   5. An engineering school catalogue or engineering school pamphlet—(26 instances)

7. If it was some other experience, it was (out of 243 replies)
   1. Your grades in mathematics or science—(140 instances)
   2. Seeing a space satellite—(4 instances)
   3. Results of an interest test—(27 instances)
   4. Participating in or visiting a "science fair"—(25 instances)
   5. A visit to an industrial plant or a military or naval installation—(37 instances)

8. What encouragements strengthened your decision to choose engineering?
   1. Advice of parents, friends or teachers—(275 out of 684 or 40%)
   2. Relatively high pay enjoyed by engineering graduates—(188 out of 684 or 27%)
   3. Prestige of the profession—(142 out of 684 or 21%)
   4. A lecture at your school by an engineer—(69 out of 684 or 10%)
   5. Experience in the Armed Services—(10 out of 684 or 2%)

9. What types of part-time or full-time work experience helped to crystalize your decision?
   1. Construction work (carpenter's helper, electrician's helper, sheet metal worker or other)—(14%)
   2. Engineering aide or laboratory assistant—(9%)
   3. Machine operator; auto mechanic—(10%)
   4. Stock clerk or grocery clerk—(10%)
   5. Your work experience did not affect your decision—(57%)

10. What features of engineering work, as you see it, are most attractive to you?
    1. Designing structures or machines, including electronic equipment—(286 out of 580 or 49%)
    2. Consulting engineering—(27 out of 580 or 5%)
    3. Research—(207 out of 580 or 36%)
    4. Managing a plant to improve its efficiency—(43 out of 580 or 7%)
    5. Selling engineering products or equipment—(17 out of 580 or 3%)

In *items 11 through 15*, the student was requested to estimate his class standing in five subjects. These self-ratings ranged from excellent (top 20%) to low (lowest 20%). The results are presented in Table I.

The sixteenth item asked: "What general scholastic rank did you have upon graduation from high school?"

1. Top tenth—(103 out of 451 or 23%)
2. Second tenth—(140 out of 451 or 31%)
3. Third tenth—(145 out of 451 or 32%)
4. Fourth tenth—(49 out of 451 or 11%)
5. Fifth tenth—(14 out of 451 or 3%)

17. What hobby occupied most of your spare time in high school? (Mark two if it is hard to decide between them.) (617 replies)
    1. Sports—(38%)
    2. Model-making, mechanical work or handicraft—(20%)
    3. Music and arts—(9%)
    4. Scientific, including electronics—(18%)
    5. None of the above—(15%)

18. If you answered "1" in the above, were you usually (out of 382 replies)
    1. On high school varsity squads—(114 instances)
    2. On high school class teams—(64 instances)
    3. In a gymnasium class—(56 instances)
    4. In a neighborhood club—(53 instances)
    5. In informal "pick-up" teams—(95 instances)

19. For more than 3 months, have you been a member of a neighborhood or community organization such as (731 replies)
    1. Church—(39%)
    2. Boy Scouts or Explorer Scouts—(25%)
    3. Social Club—(12%)
    4. Athletic Club—(10%)
    5. Group not mentioned above—(14%)

20. Beyond reading for the book reports required in most school courses in English, about how many books did you read last year? (383 replies)
    1. One or more per week—(6%)
    2. About one in two weeks—(12%)
    3. About one per month—(47%)
    4. Rarely (two or three per year)—(30%)
    5. Practically never—(5%)

21. Assuming that you checked 1, 2, or 3 above, you read mostly
    1. General fiction—(28%)
    2. Historical fiction—(17%)
    3. Science fiction—(16%)
    4. Scientific books—(24%)
    5. Mysteries, adventure or detective stories—(15%)

22. Almost eveyone has access to magazines. If you had to choose, you would rather read ones such as (613 replies)
    1. *Popular Science or Popular Mechanics*—(50%)
    2. *Readers' Digest*—(21%)

TABLE I—PERCENTAGES OF STUDENTS IN EACH LISTED CLASS SUBJECT WHO ESTIMATED THEIR CLASS STANDING IN EACH OF FIVE RATING CATEGORIES.

Rating of Class Standing in Each Subject	Class Subjects				
	(Item 11) English N-479	(Item 12) Physics N-479	(Item 13) Chemistry N-478	(Item 14) Math. N-483	(Item 15) Language N-463
1. (top 20%) Excellent	19%	34%	34%	38%	17%
2. (second 20%)	40%	39%	39%	42%	25%
3. (middle 20%) Average	36%	24%	24%	18%	39%
4. (fourth 20%)	5%	3%	3%	2%	14%
5. (lowest 20%) Low	0	0	0	0	5%

3. *Time* or *Newsweek*—(15%)
4. *Look* or *Life*—(10%)
5. *Saturday Evening Post*—(4%)

23. My father's occupation could be classed as:
    1. Professional or executive—(24%)
    2. Mechanical or trade—(45%)
    3. Clerical or sales—(16%)
    4. Service, including owner of a service business—(13%)
    5. Teaching—(2%)

24. My mother's occupation:
    1. Housewife—(64%)
    2. Clerical, Secretarial—(20%)
    3. Factory work—(9%)
    4. Sales work—(6%)
    5. Teaching, part or full-time—(1%)

25. My father's education:
    1. College graduate—(9%)
    2. Some college (or equivalent)—(19%)
    3. High school graduate—(27%)
    4. Vocational school graduate or some high school—(23%)
    5. Grammar school—(22%)

26. My mother's education:
    1. College graduate—(4%)
    2. Some college, junior college or secretarial school—(16%)
    3. High school graduate—(41%)
    4. Some high school—(25%)
    5. Grammar school—(14%)

27. Your position in your family group is as follows:
    1. Oldest—(52%)
    2. Youngest—(17%)
    3. Only child—(14%)
    4. Middle (second or third in four)—(12%)
    5. Member of a family of more than four children (5%)

28. About how much have you saved from earnings to pay your college expenses?
    1. Less than $100—(17%)
    2. $100 to $299—(28%)
    3. $300 to $399—(15%)
    4. $400 to $599—(17%)
    5. $600 or more—(23%)

29. How many hours per week did you study at home in your last year in high school?
    1. From 3 to 5 hours—(22%)
    2. From 6 to 10 hours—(35%)
    3. From 11 to 14 hours—(26%)
    4. 15 hours or more—(9%)
    5. Very little outside of time in school—(8%)

30. Why did you choose to attend the Newark College of Engineering rather than another engineering school? (many men gave two reasons)
    1. Father's advice—(40 out of 846 or 5%)
    2. Friend's advice—(43 out of 846 or 5%)
    3. Low cost. Could live at home—(360 out of 846 or 43%)
    4. Reputation of the college—(351 out of 846 or 42%)
    5. Visit to the college—(42 out of 846 or 5%)

Similar studies at other engineering colleges would be helpful in more sharply defining some of the important factors leading to the choice of an engineering college program of study in somewhat different educational environments.

SCOTT DEAN AT NORTHEASTERN

Dr. Ronald A. Scott, Boston, has been appointed Dean of Northeastern University's College of Engineering.

Dr. Scott is replacing Dr. William T. Alexander who had served as Dean of Engineering at Northeastern for the past 35 years. Dr. Alexander was recently named head of Webb Institute of Naval Architecture, Long Island, New York.

Polytechnic College of Pennsylvania

(A Forgotten College)

JAMES G. McGIVERN

Dean of Engineering, Gonzaga University, Spokane, Washington

Prior to the Civil War the number of liberal arts colleges increased from 8 in 1780 to 516 in 1860.[1] Of these 516 early colleges only 104 were in existence by 1929. It is, therefore, understandable that the histories of many of these 412 discontinued colleges are not available for study. By 1850 there were 72 theological, 48 medical, 18 law and 3 dental schools in existence.[2] With the exception of the theological schools the majority of these professional institutions were proprietary in character. Their histories are known as they later became attached to colleges and universities that are currently operating.

In contrast to the above situation it is difficult to explain how an engineering school founded before the Civil War, and in existence for at least thirty years, could be forgotten. This difficulty of explaining a forgotten college arises from the fact that up to the passing of the Morrill Act of 1862 only nine schools had been established to teach engineering in the United States. These schools with the dates of their founding were the American Literary, Scientific, and Military Academy (1819), Gardiner Lyceum (1822), Rensselaer Polytechnic Institute (1824), Union College (1845), the Lawrence Scientific School of Harvard (1847), the Sheffield School of Yale (1847), the Chandler School of Darthmouth (1851), the Polytechnic College of Pennsylvania (1853), and the University of Michigan (1855).

The first of these schools was a civilian model of West Point that in 1834 became Norwich University. The second school, known as the Gardiner Lyceum, closed down in 1832 when the Maine legislature withdrew its support. The histories of these two institutions are well known and frequently mentioned in the literature of engineering education. All but one of the seven remaining institutions are still operating as engineering schools. The school not known and no longer in existence is the Polytechnic College of Pennsylvania, which may well be called the "forgotten college." This terminology is employed because, with the exception of a limited reference by Read,[3] its name is not mentioned in the literature of engineering education.

The writer's first knowledge of this school is based on a letter written by Hiram Stifer of the class of 1876 to the editor of the *Engineering News*. This letter was in the form of a question inquiring why the Polytechnic College of Pennsylvania had been omitted from a published list of engineering schools of the nineteenth century. Immediately following Stifer's letter, the following note appeared:

> *Reply by Editor.*—We have no knowledge of this institution other than that given in our correspondent's letter. It is in none of the lists of the Bureau of Education as far as we have discovered.[4]

On November 10, 1892, a second letter, written by Dan Carthart of the class of 1857,[5] appeared. This letter gave the date of the school's founding, its president, and some of the accomplishments

[1] S. E. Morison and H. S. Commager, *The Growth of the American Republic* (New York: Oxford University Press, 1937), Vol. 1, p. 409.

[2] N. M. Butler, *Professional Education in the United States* (New York: New York Book Company, 1910), p. 466.

[3] Thomas T. Read, "The Development of Mineral Industry Education in the United States," *American Institute of Mining and Metallurgical Engineers*, New York, 1941, p. 36.

[4] Hiram J. Stifer, "Letter to the Editor," *Engineering News* (Aug. 25, 1892), p. 187.

[5] Dan Carthart, "Letter to the Editor," *Engineering News* (Nov. 10, 1892), p. 438.

of the school. No reply followed this letter but prior to this, on October 10, 1892, the editor had published a list of colleges having graduates who were members of the American Society of Civil Engineering. Included on this list and ranking ninth out of the 42 schools was the Polytechnic College of Pennsylvania. Apparently the list was reprinted from a study of the Civil Engineering Society, as the editor discredits the school's existence in the following footnote:

> If the Polytechnic College of Pennsylvania (of which we know nothing) should be added to the University of Pennsylvania the per cent then becomes 19.19 which better accords with the standing . . .[6]

This rather arbitrary treatment of the existence and the accomplishments of the school has stimulated this investigation. Its purpose is to present sufficient information with the hope of taking the Polytechnic College of Pennsylvania out of the category of the "forgotten college."

The Charter and Establishment of the College

The establishment of the Polytechnic College of Pennsylvania was accomplished through the efforts of Dr. Alfred L. Kennedy, who had previously organized the Philadelphia School of Chemistry in 1842 when only 24 years of age. From 1842 to 1852 he was also professor of medical chemistry in the Philadelphia College of Medicine and lecturer in agricultural chemistry at the Franklin Institute in 1852. Following the preliminary organization in 1851 and before the charter for the Polytechnic College was granted in 1853, Kennedy began an inspection of the Polytechnic Institutions of Europe with the following results:

> After an absence of a year he (Kennedy) reported the results of his visit, recommending that no one foreign institution be accepted as a model for the college, but that a plan be adopted based upon both the German and the French method, viz: Those practiced by Carlsruhe in the Polytechnischen Schule, and at Paris in L'Ecole Centrale des Arts — which recommendation was approved.[7]

The type of institution having been decided on, a charter was prepared and approved on April 5, 1853, by a law enacted by the Senate and House of Representatives of the Pennsylvania General Assembly.[8] This original charter made the governor of the state an ex-officio member and president of the board of trustees. The trustees were to be 27 in number, representing twelve counties and the city of Philadelphia. They were empowered to grant degrees and gave as their object "the education of youth in the arts, sciences, languages and literature, particularly mining engineering, and the natural sciences, in their application to the arts and manufactures. . . ."[9] This practice of having representation from the areas the school was to serve was as unique as the idea of not copying any one European institution. Hence Kennedy can be considered a pioneer in the work of higher education by creating an American institution responsive to the needs of the area that the college was designed to serve. In addition to Kennedy and his trustees, others saw the need for the school and had faith in its future. Typical of the support the school received is the following quotation from the *Pennsylvania School Journal:*

> The "applied sciences" will be at home in Philadelphia. All the elements are there. The commercial capital of a state abounding in wealth, manufacturers and mines — herself rich in means, enterprise and science, — all that is necessary for her is to "apply" the scientific to the practical and mechanical skill already possessed, and give rigor to the union by judicious use of her wealth, and the object is effected. We look upon this as the first step toward the establishment of that great national University of which our noble city is by position, merit, and right of priority the natural home.[10]

[6] A. M. Wellington, "Engineering Schools of the United States," *Engineering News* (Oct. 20, 1892), p. 376.

[7] "Polytechnic College of Pennsylvania," *Pennsylvania School Journal* (July, 1853), p. 181.

[8] Act Number 204 of the Laws of Pennsylvania, 1853.

[9] *Ibid.*, Sec. 6.

[10] "Polytechnic College of Pennsylvania," *Pennsylvania School Journal,* (July, 1853), p. 8.

The Academic Program of the Polytechnic College

Wickersham throws some light on Kennedy's reasons for having wide distribution among the trustees. In addition, he also describes the development of the school:

> His (Kennedy's) aim was to build up a great State institution with students sent from the different counties under State patronage. The corporators named in the charter were leading men residing in sections of the State. Dr. Kennedy was its first and only President. The institution began with two technical schools, those of Civil Engineering and of Chemistry and Metallurgy. In 1854 the School of Mechanical Engineering was added; in 1857, the School of Mines, and in 1858, the School of Architecture. The State aided the institution, in 1867, by an appropriation of $5000, but it has otherwise been compelled to rely for support wholly upon tuition fees and private subscriptions. When most prosperous it maintained a competent professor at the head of each of its departments, and was attended by a considerable body of students; but devoted as its President has always been to its interests, he had found it impossible of late years to prevent a marked reduction in the size of its classes.[11]

In addition to the above schools that were operated within the college, an academical department was created in 1854 whose purpose is described in the eighteen-page second annual announcement of the school:

> This department recently organized by the board of trustees, will be open in the College Building on Monday, September 4, 1854.
>
> Students whose deficient English and Mathematical Education disqualifies them from joining the College Classes, will be received into this Department at any time, and be rapidly prepared, by special instruction, to enter College.[12]

By adding this academical department a structural form was created for an institution of the truly Polytechnic type. This intention of the founder is clearly stated in the third annual announcement of the college:

> Its provisions are broad and liberal. It includes five Departments mutually dependent. The establishment neither of a School of ENGINEERING nor of MECHANICS, nor of CHEMISTRY, nor of MINES, nor of AGRICULTURE alone, could have fulfilled the objects contemplated in the founding of this institution — any might have furnished half-educated graduates; but their union in a POLYTECHNIC COLLEGE affords an education solid, elevated, and usefully applicable in all the higher departments of construction and of production—one which provides for a wider field of honorable employment than any which has hitherto been afforded.[13]

Prior to this time Rensselaer Institute had been reorganized by Green in 1849-50 with the objective of extending the course offerings beyond the then existing civil engineering program. In actually creating an enlarged operation Kennedy was ahead of Rensselaer as the following quotation indicates:

> . . . While they (Rensselaer) would defer any attempt to effect the more complete development of their plans, including the important specialities of Architecture and Mining Engineering, to a period when they might hope to be able to invoke effectively the aid of conditions more favorable to realizations so desirable.[14]

The only other institution that was established to accomplish these same objectives was the Massachusetts Institute of Technology, which followed the Polytechnic College of Pennsylvania by a considerable number of years. Yet in the following statement Mann fails to give the "forgotten college" credit in his description of the purpose of the Massachusetts Institute:

> The first schools offered only one course — civil engineering. The Massachusetts Institute of Technology opened in 1865 with six curricula leading to degrees in civil, mechanical, and mining engineer-

[11] James P. Wickersham, *History of Education in Pennsylvania* (Inquirer Publishing Company, 1886), p. 432.

[12] *Second Annual Announcement of the Polytechnic College of Pennsylvania,* Pamphlet Vol. No. 15, Pennsylvania State Library, Harrisburg, Pennsylvania, p. 16.

[13] *Third Annual Announcement of the Polytechnic College of Pennsylvania,* Pamphlet Vol. No. 15, Pennsylvania State Library, Harrisburg, Pennsylvania, p. 22.

[14] Palmer C. Ricketts, *History of Rensselaer Polytechnic Institute* (New York: John Wiley and Sons, 1934), p. 94.

ing, practical chemistry, architecture, and general sciences.[15]

These comparisons certainly place the work of Kennedy as being well ahead of his time. In addition to the contribution of developing one of the first comprehensive programs, if not actually the first, he was also first in offering degree programs in the three fields of mechanical engineering, mining engineering, and in architecture. But nobody has credited him so far with offering the first mechanical engineering course. Even in his own day the following quotation will show Kennedy was disregarded:

> On Oct. 5, 1870 Professor Trowbridge delivered an Inaugural Address before the Sheffield Scientific School on the "Profession of Mechanical or Dynamical Engineer," in which he made the statement that "this is the first instance in this country in which an institution of learning had adapted a systematic course of instruction having for its object the preparation and training of young men for the pursuit of the comparatively new profession.[16]

This failure to credit the Polytechnic College with initiating new programs of study was not limited to mechanical engineering. The same situation existed in the field of mining engineering. In this regard Columbia is credited with having established the first school in 1863, without mention of the degree programs offered at Philadelphia in 1857. Typical of this point of view is the following statement by Thurston:

> Columbia College, New York City, established its "School of Mines" — which promptly became the principal American school in mining engineering in 1863, as the first mining school in the United States.[17]

Enlarging on the reorganization of Rensselaer previously referred to, the following statement shows that although Greene planned an architectural curriculum in 1850 it was many years before it offered a complete architectural course. This statement supports the contention that it was the Polytechnic College which operated the first architectural course in 1858.

> When the curriculums were reorganized in 1849-50, Director Green laid special emphasis upon the advisibility of establishing a department of architecture as well as one in engineering; and he developed, at that time, the first curriculum for a course in architecture to be created in any institution of learning in this country. Lack of funds prevented the organization of this course.[18]

With reference to the various degree programs of the "forgotten college," the following detailed course listings are taken from the catalogue of the Tenth Session for the school year (1862-63).[19] It will be noticed that all these degree programs are two years in length. No information is available on the three-year programs offered in 1871 which are referred to in the *Pennsylvania School Journal* of that year.

For the Degree of Bachelor of Civil Engineering

First Year Course

- Mathematics
- General Chemistry
- General Physics
- General Mechanics
- Field Practice (Commenced)
- Drawing (Topographical)
- Mineralogy

Second Year Course

- Mathematics, Civil Engineering, and Practical Geology
- Applied Mechanics
- Architecture
- Industrial Physics
- Drawing and Modelling

[15] Charles R. Mann, *Study of Engineering Education* (New York: Carnegie Foundation for the Advancement of Teaching, 1918), Bulletin No. 11, p. 7.

[16] Russel H. Chittenden, *A History of the Sheffield Scientific School* (New Haven, Conn.: Yale University Press), Vol. 1, p. 150.

[17] R. H. Thurston "Technical Education in the United States," *Transactions of the American Society of Mechanical Engineers*, New York, Vol. 14, 1892, p. 993.

[18] Ricketts, p. 150.

[19] *Tenth Annual Announcement of the Polytechnic College of Pennsylvania* Pamphlet Vol. No. 223, Pennsylvania State Library, Harrisburg, Pennsylvania.

For the Degree of Bachelor of Mechanical Engineering

First Year Course
- Mathematics
- General Chemistry
- General Physics
- General Mechanics
- Drawing (Mechanical)
- Mineralogy

Second Year Course
- Mathematics
- Geology
- Construction of Machines
- Metallurgy
- Applied Mechanics
- Industrial Physics
- Drawing and Architecture

For the Degree of Bachelor of Chemistry

First Year Course
- General Chemistry
- General Physics
- Mineralogy
- Geology
- Laboratory Practice

Second Year Course
- Industrial Chemistry
- Analytic Chemistry (Practical)
- Agricultural Chemistry
- Industrial Physics
- Metallurgy
- Natural History (Plants)
- Drawing or a Modern Language

For the Degree of Bachelor of Mine Engineering

First Year Course
- Mathematics
- General Chemistry
- General Physics
- General Mechanics
- Mineralogy
- Drawing

Second Year Course
- Mathematics
- Geology and Mineral Analysis
- Mine Engineering
- Applied Mechanics
- Metallurgy
- Industrial Physics
- Drawing

For the Degree of Bachelor of Architecture

First Year Course
- Mathematics
- General Chemistry
- General Physics
- General Mechanics
- Mineralogy
- Drawing and Coloring

Second Year Course
- Mathematics
- Geology
- Industrial Physics and Chemistry
- Applied Mechanics
- Principles of Architecture
- Modelling in Clay and Plaster
- Drawing, Coloring, and Designing

An examination of the above curricula shows the similarity between the courses offered for all the degrees with approximately three-fourths of the work common to all programs. In comparison with American schools it indicates the European influence, since all courses of the European programs were technical in nature as compared to the study of English, foreign language and history taught in the American technical schools. At the Polytechnic College those deemed deficient in English and elementary mathematics were required to take a preliminary year before enrolling in a professional course.

The Plant, Enrollment and Degrees Awarded

To supply evidence that the college had adequate physical facilities to begin its work, the following description is of interest:

> . . . have secured the large and elegant building at the southwest corner of West Penn Square and Market Street, lately the passenger depot of the Central Railroad. The college edifice was originally constructed for banking purposes; its situation is, in all respects most favorable and its lofty and spacious rooms are well adapted to the uses of the institution.[20]

With the addition of more schools within the Polytechnic College more

[20] *Pennsylvania School Journal* (July, 1853), p. 8.

space was needed. Without stating how the money was obtained, the *Pennsylvania School Journal* describes a new building designed and constructed specifically for the purposes of the school.

> . . . the new edifice has recently been completed. This consists of a main building four stories high on Market Street, and two rear wings or pavilions extending southward; that on the east being 117 feet long and three stories in height; that on the west, 117 feet and two stories high, for the better lighting and ventilation of the court yard.[21]

Because complete records are not available, a continuous picture of the institution, over the years of its existence, is not possible. There is, however, sufficient material to indicate its prominence and the contributions it made during the period of its existence.

The catalogue of 1855-56 lists 34 students in the professional schools and 33 students in the academic department, giving a total of 67 students. The catalogue of 1862-63 is the most interesting of all. This picture of the college during the civil war lists 94 students and the granting of 13 bachelor's degrees and 1 master's degree. There were 7 "Bachelors of Civil Engineering," 3 "Bachelors of Mechanical Engineering," 2 "Bachelors of Mine Engineering," and 1 "Bachelor of Chemistry." The degree of Master of Civil Engineering was awarded on the basis of three successful years of practice after receiving the degree of Bachelor of Civil Engineering. In granting 13 bachelor's degrees the school awarded the largest number of engineering degrees given by an institution in 1863. The corresponding figures for the other schools are Rensselaer (12, Harvard (5), Michigan (5), Yale (4), Darthmouth (2), and Union College (2).[22]

Other material on enrollments is limited to a listing in the Annual Report of the United States Commission of Education for the year 1877.[23] In this report the college is listed as having 11 full-time staff and one part-time professor. Sixty-five students were registered as taking the full course and four as taking a partial course. The course for this year (1877) is listed as being three years in length, with the third year or senior class numbering 21. If all this class received degrees it would be for that year the second largest school in the United States with respect to graduating engineers. It would have been ahead of Michigan, which granted 18, and second only to Rensselaer, which graduated 27.

Another index of the school's importance can be measured by the number of engineering graduates who were members of the American Society of Civil Engineering during the years between 1867 and 1892 as compiled by Wellington.[24] This list corrects one previously cited in the introduction of this paper and credits the Polytechnic College with 19 graduates who were society members. This number placed the school eighth on a list of 43 colleges. As a measure of relative importance these figures would be conservative, because the school from its beginning was strong in divisions other than civil, and many of its graduates may have joined the American Institute of Mining and Metallurgical Engineering, founded in 1871, or the American Society of Mechanical Engineers, founded in 1880.

A final important enrollment figure is that quoted by Read, who states than an alumni list of the Polytechnic College of Pennsylvania shows 369 graduates prior to 1890. If this is compared with the number of engineering graduates of 52 colleges given by Wellington in 1892, it is found that, although unlisted, the Polytechnic College would place fourth in the list. It would be surpassed by Rensselaer with 664, Columbia with 488, and Yale with 425 graduates.

Conclusion

There appears to be no explanation as to why and when this college ceased to

[21] *Pennsylvania School Journal* (Dec., 1871) p. 182.

[22] A. M. Wellington, "The Supply and Demand of Engineers," *Engineering News* (Aug. 4., 1892), p. 111.

[23] Report to the U. S. Commissioner of Education, 1877, p. 541.

[24] A. M. Wellington "Addendum as to the Membership in the American Society of Civil Engineers," *Engineering News* (Nov. 17, 1892), p. 471.

exist. From the material available it would appear that it operated beyond 1878 and possibly as late as 1886. It is not proposed to supply possible reasons as to why it closed. What has been attempted is the presentation of sufficient material to place the contributions of Dr. Kennedy and the Polytechnic College of Pennsylvania in their proper light. Admittedly the material has been insufficient to supply a continuous historical record. What has been presented, however, is sufficient to reclassify the institution from the status of the "forgotten college" to one of the few pre-Civil War schools that set the pattern for the many engineering schools now in existence. What was written of the Polytechnic College of Pennsylvania in 1871 is true today:

> . . . If the history of the College shall ever be written, it will, we think, prove to be one of the most interesting and instructive episodes in the growth of technical education in America.[25]

[25] *Pennsylvania School Journal* (Dec., 1871), p. 181.

NEW APPOINTMENTS AT BANGKOK

New appointments have been made at the SEATO Graduate School of Engineering in Bangkok operated by the Colorado State University Research Foundation under contract with ICA. Dr. Robert M. Holcomb, Professor at Texas A & M College has been appointed dean to succeed Dean T. H. Evans, who has just returned to Colorado State University. Dr. Robert B. Banks, Assistant Dean for Research and Graduate Studies at Northwestern University has been appointed Director of Research to succeed Dr. Marion R. Carstens, who has returned to Georgia Institute of Technology.

The new appointments are for approximately two years.

NEW GRADUATE PROGRAM IN "BIOMEDICAL ENGINEERING"

A new graduate curriculum which integrates the engineering and medical sciences was initiated by The Johns Hopkins University in September.

The new program in "Biomedical Engineering" leading to the doctoral degree is the first of its kind in the country. Two other institutions, the University of Pennsylvania and the University of Rochester, are cooperating with Johns Hopkins in instituting similar programs.

Students enrolled will take course work both in the School of Medicine in East Baltimore and at the Homewood Campus. At least four years of study and research will be required to fulfill the requirements for the degree with an additional year of post-doctoral study in biomedical research recommended.

The purpose of the new program is to train students in advanced engineering subjects of particular pertinence to research in biological systems and to offer systematic study in how the principles of physical and engineering science apply to biological systems.

Sixth Survey of Engineering Technician Enrollments and Graduates

1960-1961

DONALD C. METZ

Chairman, Manpower Studies, Technical Institute Division of ASEE, and Director, Technical Institute, University of Dayton

This is the sixth survey of engineering technician enrollments and graduates. Constant effort has been made to improve the gathering of data and the reporting of final results. Too great a lag still exists between the time the survey is started (October each year) and the time sufficient results are available for use.

For the first time comparable data are available for a substantial number of schools. This has been the result of a suggestion that we separate data of schools which have not reported for each of the last two years so that data for "Other Institutions" might be compared as well as data from institutions with ECPD approved curriculums. In the latter case we have in the past adjusted reports to reflect the data for schools listed in the current ECPD report of accredited technical institute programs.

Of the 200 usable replies received for 1960-61, 32 did not furnish data in 1959-60. Likewise, of the 225 schools reporting in 1959-60, 57 failed to reply in 1960-61. These institutions in each case represent from 9 per cent to 14 per cent of the total number of enrollment and graduates.

Table 1 shows the enrollment as of October 1, 1960. The new plan for presenting data results in an overall increase in enrollment of about two per cent from 63,115 to 64,240. The downward trend in both full-time and part-time enrollment at ECPD institutions is offset by compensating increases at other institutions. This is the second year for such a decrease (20 of the 33 schools reported decreases in full-time enrollment) and it is the belief of some persons that the raising of entrance requirements may be a major factor. Overall enrollment continues to indicate a national engineering technician enrollment of approximately 75,000 in some 200-250 schools.

Table 2 shows estimated numbers of graduates for 1960-61. Here again ECPD institutions show a decrease reaching approximately 12.5 per cent, which in this case is not offset by the very slight increase from other institutions. The net result is an overall decrease of 4.2 per cent from 13,381 in 1959-60 to 12,818 in 1960-61. Once more some believe the continued decrease in the number of graduates is occasioned by a stiffening of standards as well as by economic and other factors. There is still no evidence to indicate we are graduating more than about 11,000 to 12,000 engineering technicians from full-time programs and a total of 15,000 to 16,000 nationally.

The fact remains that the story is not getting through to the public in spite of continued technological change and the demand for more and more education for those who can profit by it. To a great extent two-year college-level programs of technical education can supply this need.

TABLE 1—ENROLLMENTS IN ENGINEERING TECHNICIAN PROGRAMS

		No. of Institutions	1960–61			1959–60		
			Full-time	Part-time	Total	Full-time	Part-time	Total
REPORTED BOTH 1959 AND 1960								
Institutions with at least[1] one ECPD-Approved curriculum		(33)[2]	16,438 (33)	7,370 (25)	23,808	17,271 (33)	8,382 (21)	25,583
Other Institutions		(135)	14,972 (120)	25,460 (104)	40,432	13,228 (120)	24,304 (97)	37,532
Subtotals[3]		(168)	31,410 (153)	32,830 (129)	64,240	30,449 (153)	32,616 (118)	63,115
Other Institutions								
Reported 1959 Only		(57)	—	—	—	5,562 (54)	4,820 (33)	10,382
Reported 1960 Only		(32)	4,118 (31)	2,862 (21)	6,980	—	—	—
Totals	1959	(225)	—	—	—	36,061 (207)	37,436 (151)	73,497
All Institutions	1960	(200)	35,528 (184)	35,692 (150)	71,220	—	—	—

[1] Data for 1959-60 and 1960-61 based on schools having ECPD accredited programs as announced in the 1960 Annual Report. All data from 1959-60 Fifth Survey adjusted to show this change.

[2] The figures in parentheses indicate the number of schools reporting in each category. These figures do not coincide with the total number of institutions included in the survey since all schools did not report both full-time and part-time enrollments and graduates.

[3] Figures in both tables through sub-totals are comparable between years since reports from same schools were used both years.

TABLE 2—GRADUATES FROM ENGINEERING TECHNICIAN PROGRAMS

		No. of Institutions	1960–61			1959–60		
			Full-time	Part-time	Total	Full-time	Part-time	Total
REPORTED BOTH 1959 AND 1960								
Institutions with at least[1] one ECPD-Approved curriculum		(33)[2]	5,601 (33)	683 (20)	6,284	6,031 (33)	1,153 (16)	7,184
Other Institutions		(135)	3,948 (113)	2,586 (78)	6,534	3,815 (108)	2,382 (59)	6,197
Subtotals[3]		(168)	9,549 (146)	3,269 (98)	12,818	9,846 (141)	3,535 (75)	13,381
Other Institutions								
Reported 1959 Only		(57)	—	—	—	1,323 (43)	550 (21)	1,873
Reported 1960 Only		(32)	1,126 (30)	192 (14)	1,318	—	—	—
Totals	1959	(225)	—	—	—	11,169 (184)	4,085 (96)	15,254
All Institutions	1960	(200)	10,675 (176)	3,461 (112)	14,136	—	—	—

[1] Data for 1959-60 and 1960-61 based on schools having ECPD accredited programs as announced in the 1960 Annual Report. All data from 1959-60 Fifth Survey adjusted to show this change.

[2] The figures in parentheses indicate the number of schools reporting in each category. These figures do not coincide with the total number of institutions included in the survey since all schools did not report both full-time and part-time enrollments and graduates.

[3] Figures in both tables through sub-totals are comparable between years since reports from same schools were used both years.

A Proposal for Increased Articulation Between Technical Institutes and Engineering Colleges

IRVING L. KOSOW

Professor and Department Head, Electrical Technology
Staten Island Community College

The recently published report on the National Survey of Technical Institute Education[1] (hereinafter referred to as the Henninger report) once again confirmed the findings of a number of earlier studies—that of the President's Committee on Scientists and Engineers, the Grinter report (so-called) undertaken for the American Society for Engineering Education,[2] and a parallel study undertaken by the University of Wisconsin.[3] For the sake of emphasis, it should be noted that each of these studies emerged with similar findings and recommendations. The findings (subject to the general hazards of oversimplification) may be stated as follows:

1. There is a shortage of engineers and scientists in the United States which is likely to continue.
2. There is and has been an excessive and unwarranted number of graduates from four-year institutions of engineering and science who are employed in industry at the technician level, and whose capacities and training are not being fully utilized.
3. In the past three years, there has been a significant and progressive decline in total engineering enrollments despite the general increase in college enrollment, the employment opportunities for engineering graduates and the corresponding enlargement of facilities of higher education.
4. The technical institute program must be expanded to provide an increased number of high-level technicians to meet the need of our automated, complex technology and to free badly needed engineers and scientists for more advanced tasks.
5. The occupational classification known as the engineering technician has come to be recognized generally as the newest member of the industrial triumvirate — engineer, engineering technician, and mechanic (or tradesman). Each serves a function in and each is indispensable to industry.
6. The technical institute can no longer be considered inferior by faculties of science and engineering colleges merely because it is a two-year institution. In the national interest, it must be recognized as an integral part of engineering educa-

[1] G. Ross Henninger, "The Technical Institute in America," JOURNAL OF ENGINEERING EDUCATION, Vol. 51, No. 1 (October, 1960), pp. 31-36. A summary of the major findings of a study conducted for the ASEE under a supporting grant from the Carnegie Corporation of New York. Presented at the annual meeting of the ASEE at Purdue University, June 1960, by President Henninger.

[2] American Society for Engineering Education, *Report on Evaluation of Engineering Education.* Illinois: The Society, 1955.

[3] R. E. Purucker, "Graduate Training Based on Undergradute Training in Fundamentals," JOURNAL OF ENGINEERING EDUCATION, Vol. 47, No. 3 (November 1956), pp. 223-227.

Presented at the Regional Conference, State University of New York, January 1961.

tion, specifically, and higher education, generally.

The last of the above recommendations recalls the findings of the largely ignored (however perspicacious) Wickenden-Spahr report.[4] This study, undertaken almost three decades ago, examined technical institutes both in this country and abroad. It concluded with the recommendation that higher education, in failing to recognize the potential role of the technical institute, was doing an injustice to both the country and the youth of our nation.

Bitter vindication of this early study, as well as those cited previously, was made by the recent Engineers Joint Council Delegation to the Soviet Union. This group noted that the U.S.S.R. produced annually for industry 250,000 industrial-technicum graduates as compared to some 15,000 annually graduated in this country. The argument immediately comes to mind in our defense to say, "But of course, our 15,000 are far better trained." "Not so!" says the spokesman of the E. J. C. Delegation. Of the 15,000 we graduate annually, "not over 1,000 are of the quality of those produced by the technicums we visited (in the U.S.S.R.)"[5]

The Henninger report, in citing the intense shortage of well-qualified technicians, revealed a truism long suspected by those of us close to the picture of industrial placement of students: industry, in effect, cannot afford "quibbling about nomenclature or ivy-covered traditions and is, of necessity, meeting the 'crash' needs of expanding science and technology for technical manpower by the direct mass-recruitment of likely warm bodies from all possible sources, including high school undergraduates."[6]

In comparison to previous studies, perhaps the most original contribution of the Henninger report is the realization embodied in the following categorical and overt statements:

> The technical institute program is no more 'terminal' than any other college degree program.[7]
>
> The definition of the engineering technician, to the extent to which it is specific and limiting, applies to the *starting* point in his professional career rather than to the *finishing* point.[8]
>
> The function of formal education is preparational, not restrictive.[9]
>
> The route to the top, in continuance of the fundamental American tradition, *must always be open around as well as through* formal curricular classroom instruction. The various state registration laws reflect this basic concept.[10]

Mr. Henninger and the members of his survey team are to be congratulated for placing the problem squarely where it belongs—in the hands of engineering educators and administrators who should consider ways of implementing admission of technical institute graduates to engineering colleges. In view of the recommendations made by past studies, one wonders how frequently the gauntlet must be dropped before engineering educators will rise to accept and meet the challenge implicit in this report. It is clear from this (as it was from previous reports) that in the interests of national security something must be done—and soon. But what? The Henninger survey figuratively *demands* a hard, bold and new look at both the technical institute and four-year engineering curriculums by all concerned. We, as educators, are hardly expected to, nor shall we if previous apathy is any indication, devote our entire effort to the solution of this (one of many) crisis in education. On the other hand, we cannot accept nor do there appear to be makeshift solutions. The findings stated in the first paragraph of this paper serve to identify the broad aspects of the problems facing engineering education. If real and purposeful solutions are to emerge, it is necessary that the major and minor problems ensuing from these broad policy statements be clarified by careful separations and definitions—so operationally stated—to stimulate some educators to attempt experimentation and modification

[4] Society for Promotion of Engineering Education, *A Study of Technical Institutes*. Lancaster, Pa.: The Society, 1931.

[5] "Technician Training in the Soviet Union," *School Shop*, Oct. 1960, p. 60.

[6] Henninger, p. 32.

[7] Henninger, p. 35.

[8] Henninger, p. 36. Italics mine.

[9] Henninger, p. 36.

[10] Henninger, p. 36. Italics mine.

in the curriculums of both the two and four-year institutions.

Why Tamper?

Engineers, whether in industry, engineering colleges or technical institutes, are a conservative lot, by nature, trained to segregate, classify, standardize and evaluate before drawing conclusions or recommending changes. The doctrine of separation between the accredited four-year baccalaureate institution and the two-year terminal, technical institute represents a logical, neat and ordered dichotomy. Why tamper with it when it is so perfectly and understandably structured? Anyone can grasp the difference readily. The engineering college is (as a minimum) a four-year institution; the technical institute, one whose duration ranges from one to three years. The former provides for ready transfer of credits from one accredited four-year institution to another; the latter's credits are "suspect" and not generally transferable, even to other two-year institutions. The engineering college is designed to provide for further higher education beyond the baccalaureate degree; the technical institute is purportedly a "terminal" institution whose graduates, presumably, complete their formal education upon graduation. The four-year institution trains engineers and scientists to solve complex problems, design and develop new machines and devices, discover new principles; its two-year counterpart concentrates on the application of these principles and devices. This stereotype, perhaps somewhat overdrawn but certainly convenient, has served to classify and distinguish between these two types of institutions.

If changes are to come about in both types of institutions—as they have in the past and inevitably must in the future—it will require a positive outlook on the part of engineering educators and administrators which welcomes experimentation with the curriculums, admissions and transfer policies of both these institutions. An *educational bridge* must be established between these two types of engineering institutions of higher education. A second new outlook will require a point of view, particularly by our four-year counterparts, which recognizes that the technical institute is not inferior to the four-year institution, either in terms of its importance to the national effort, the nature of its curriculum or the quality of its faculty. In the same way that elementary, junior and senior high schools are recognized by the college teacher as having essential and distinct roles in the education of our youth, so must the technical institute be accorded its status as having an essential function in engineering higher education.

It is the writer's belief that opposition to both of these progressive outlooks stems from a common source—a characteristic desire on the part of some in the four-year institutions to preserve personal status by maintaining the *status quo*. So much has been written and said about "status-seeking" as a pattern of American culture that the writer hesitates to bring proverbial "coals to Newcastle." Yet the educational "pecking-order" is so well-established that one does not require a doctoral study to sample the attitudes of the lay public or the faculty to determine the "superior" status of the graduate school over the undergraduate school, the liberal arts college over the teacher's college, the medical school over other professional schools (dentistry, law, etc.), the private prep school over the publicly supported high school, and, of course, the engineering school over the technical institute. Vance Packard notwithstanding, the perpetuation of this attitude stems from those at the top of the pecking order. What has the educational profession, in general, and the engineering educator, in particular, done to dispel this attitude?

It is of interest to note that the "Associate in Applied Science" degree has suffered primarily because of "status-thinking." On the one hand, there is the prestige of the baccalaureate degree which, in part, accounts for the increased proportion of high school graduates clamoring for entrance to the four-year institution. On the other hand, because the technical institute is relatively new on the educational scene the four-year engineering schools consider the associate degree

lightly. As a consequence, the majority of courses taken in the first two years are not generally accepted for transfer. Both of these factors have harmed the cause of the technical institute in America greatly, despite assurances from industry, numerous classified advertisements, and reports from guidance counselors that the need is so great for technicians, and that employment at a fairly respectable starting salary is virtually guaranteed upon graduation from such an institution. As a result of such status thinking, the technical institutes fail to attract a large proportion of the dropouts of the four-year engineering curriculum or a similarly large proportion of those high school graduates who fail to gain admission to the engineering school of their choice. What has happened to these young people who have some engineering aptitude and a sufficiently high engineering interest pattern but fail to make the grade? Where are they now? Certainly, a small proportion of these enter technical institutes. What can be done to eliminate this cruel waste of our nation's natural and most valuable resource—manpower?

Closing the Gap

If articulation is to occur (as it inevitably must) between engineering colleges and technical institutes, some ground must be yielded on both sides. On the one hand, the curriculum of the technical institutes may have to be upgraded to include more of the basic engineering sciences, both qualitatively and quantitatively. The four-year engineering colleges, in addition, may have to be willing to accept adequately prepared transfers from the technical institutes who have given satisfactory evidence of ability to continue their education toward a baccalaureate degree. The gap between the technical institute and the engineering college has already been bridged in the state of California where transfers occur on a fairly large scale with remarkably few repercussions.[11] While both types of institutions have much to gain by such reform, there is yet another compelling reason for increased articulation between the two. Trends, indicated by changes in courses of study in the various four-year schools, show a general movement in the direction of engineering science and away from engineering practice. A growing philosophy is emerging among engineering educators that engineering is a science rather than a technology. The role of the technician in this rapidly changing picture is noted:[12]

> The trend in professional engineering education today is clearly toward an increased emphasis on "science" at the expense of "art" and the technician or technologist is taking over many of the functions formerly performed by engineers, particularly in the areas of construction, operation and sales. It is the writer's conviction that this trend will continue and will necessitate a substantial broadening of the present highly specialized technical institute type of training. Furthermore, as the percentage of the population attending college increases, the social and economic advantages of a baccalaureate degree will militate against any "terminal" program which does not provide opportunity for continued study toward a degree without undue loss of time for students who possess the necessary ability and ambition . . . . Trends in this direction are already discernible. Several leading technical institutes have in recent years expanded their programs to provide additional work leading to a bachelor's degree.

Stimulated by the Sputnik hysteria, the insatiable appetite of industry for research-oriented personnel and the standards imposed by the graduate schools, engineering education has been compelled to place greater emphasis on research and basic design rather than practical application of scientific principles. Simultaneously, attempts are being made in various institutions to offer broader cultural and purer scientific courses (at the expense of the technical) in order to train engineering scientists capable of independent study and broader vision. Does this mean that there is no longer a need for the practising professional engineer? Hardly. In the light of more emphasis on discovery of new principles, even more practis-

[11] J. Lillie and R. E. Stockwell, "A Local Problem for Engineering Education," *Junior College Journal*, September 1959, pp. 16-25.

[12] F. R. Henderson, "Junior College Engineering Programs," *Junior College Journal*, October 1960, pp. 94-97.

ing engineers may be required than are presently being trained to solve the practical design and engineering problems associated with these discoveries. But if the engineering colleges intend to concentrate their efforts on the training of engineering scientists, what institutions are going to take up the gap? Clearly, by default, the obligation may fall upon the technical institutes. The notion is fairly prevalent among many of the writer's colleagues, teaching at the technical institute level, that the present course in Electrical Technology is equal to (and beyond, in the area of electronics) that which was offered in four-year courses of electrical engineering some 25 years ago. It is highly possible that the engineering technician course some 25 years hence will be similar to that offered by the engineering curriculum and accompanied by corresponding changes in the technical institute which must, of necessity, "take up the slack."

The Key First Year

Does the solution lie, as some believe, in the expansion of the technical institute to a four-year source of study? In the writer's opinion, this would defeat the advantages of articulation between the two types of institutions. How can articulation be implemented in a manner that will be most acceptable to both? The solution which has been suggested in numerous discussions and conferences consists of modifying the first year of the technical institute curriculum. This curriculum should be broadened so as to represent an academic achievement equivalent necessary for success in the last two years of a four-year engineering curriculum. It goes without saying that a number of the students entering engineering schools and technical institutes are inadequately prepared in basic mathematics, the sciences (notably physics and chemistry) and English expression (both written and oral), to say nothing of the foreign languages. Some of our finest and most selective engineering colleges have had to institute "remedial courses" to make up student deficiencies in some and all of the above areas.

If the first year of the technical institute were oriented toward a broad academic training (stressing the basic fundamentals of mathematics, physical sciences and English—among other subjects), paralleling but less rigorous than the first year of a pre-engineering curriculum, it would serve to advance the respective causes of the technical institute and the four-year engineering school in many ways. To begin with, it would permit the technical institute to raise the common denominator of those students who have been inadequately prepared for college work for whatever reason. Then, since such a course would require the same or similar aptitudes for success as exists in the first year of engineering school, it would permit the technical institute to guide the more successful student in the direction of the engineering sciences. This procedure, in addition, has the guidance oriented advantage of affording the student the opportunity of an additional year to discover his own potentialities to his own satisfaction. He is not told that he cannot enter the field of his choice but is permitted to discover for himself what are his limitations. It encourages, if you please, the "late bloomer" who, on the basis of previous high school record, would not have been admitted to an engineering college. This solution, further, enlarges the reservoir from which potential scientists and engineers may be drawn —and is it not the function of technical institutes and community colleges to expand the facilities of higher education and "let each become all he is capable of being?" Assuming that articulation difficulties concerning transfer of credits from technical institutes to engineering colleges can be surmounted, the more successful student, at the end of the first year of pre-engineering, would follow a sequence of courses similar to that given in the second year of an engineering college. If he succeeds, he would transfer at the end of his second year to an engineering college of his choice.

But what of the less-successful student who has enrolled in this proposed pre-engineering program at a technical institute? Or, for that matter, what of the less

successful dropout in the first or second year of a four-year course in engineering? By virtue of having been exposed to a sound foundation in mathematics, physical sciences and English, these students are certainly better prepared to comprehend and make the most of any of the more specialized technician-training programs which they may select than if they had gone directly from high school into such a program. This latter group would be "salvaged" to take their place in industry in proportion to their abilities. If the opinions offered by employment interviewers, industrial placement coordinators and engineering advisement committees to educators in technical institutes are to be given any credence, it would appear that the overwhelming majority have recommended a broader type of technical institute training with heavy emphasis on basic fundamentals rather than (and opposed to) specialized training geared to a particular industry or technical specialty. Events are moving so rapidly in technology, furthermore, that specialized study in a particular area may be rendered obsolete by future developments. In the final analysis, a solid training in mathematics, chemistry, physics and English represents the best foundation on which to build any type of technical and scientific specialization. From the point of view of industry and the best interests of the student, therefore, there is much to be gained by patterning the first year of the technical institute program along classical pre-engineering lines. Once employed, the graduate of such a technical institute program may continue his study of pure science or engineering in extension courses without too much loss of credit in subjects taken at the technical institute.

There are always those who will raise the cry that this proposal represents "a back door to engineering" and will result in a "watering down" of the engineering curriculum. To these, the writer would like to point out that such comment should be left to accreditation agencies and evaluation teams. In the final reckoning, the "controls" of the situation still remain with the engineering colleges who retain the right to accept or reject candidates with advanced standing for their various courses of study.

By way of summary, the above proposal may be considered as affording the following potential advantages:

1. It provides for increased articulation between technical institutes and engineering colleges on a basis which is more acceptable to the latter type of institution.

2. It expands the potential horizons of the technical institute and the engineering college simultaneously, both qualitatively and quantitatively.

3. It tends to raise the status of the technical institute in the eyes of educators, students and industry.

4. It conserves our nation's technical manpower by making possible fluid movement between the two types of institutions, wherein qualified technical graduates can move on to further engineering education and dropouts from engineering colleges can acquire specialized training to become engineering technicians.

5. By increasing the potential number of technical institute graduates, engineering manpower will be made available for the more creative and professional objectives of the four-year graduates in science and engineering.

METALLURGY PH.D. AT WASHINGTON

To provide specialists trained in the fundamental behavior of metals, graduate education at the University of Washington has expanded with the introduction of a new program leading to the degree of Doctor of Philosophy in the field of metallurgy, beginning the autumn quarter.

A Report on the Educational Methods Division's Midwinter Conference

Research on Engineering Faculty Utilization

EDWARD K. KRAYBILL
Professor of Electrical Engineering,
Duke University, Durham, N.C.

WILLIAM K. LeBOLD
Associate Professor of Engineering and Educational Research,
Purdue University, Lafayette, Ind.

EDWARD J. RISING
Assistant Professor of Mechanical Engineering,
University of Massachusetts, Amherst, Mass.

According to Dr. Alvin C. Eurich, Vice President and Director, The Fund for the Advancement of Education, ". . . . utilization involves essentially an engineering approach to teaching."[1]

Dr. Eurich maintains that engineers and scientists have been mainly responsible for developing the tools which have completely revolutionized modern communication. Moreover, their ingenuity also has brought about new types of analysis which have increased the efficiency of many operations and processes.

With few exceptions, however, engineers have not made use of their new developments and inventions for one of their most important needs—the teaching of engineering students, which is indeed a process of communication. Yet there is reason to believe that the thoughtful application of engineering techniques can result in a greatly improved educational process. The progress resulting from the application of engineering proficiency to other areas of endeavor appears to justify such hope, and education certainly deserves at least the same degree of imaginative thinking, objective analysis, and carefully planned experiments.

Although effective teaching may be considered, in one sense, as efficient communication, the shortage (quantitative and qualitative) of engineering teachers emphasizes the need for better utilization of engineering faculty in many ways. Invention and efficiency have transformed modern life, so why not transform education too? The engineering approach appears to be that of attempting to find ways of doing more, doing better, and doing with fewer people. Why not a dose of the same for education?

Attempting to find ways of doing more, better, with fewer people usually requires some research, of course, and in conducting research there is a demand for valid and reliable data and an objective approach. Why not the same for education rather than the widespread acceptance on faith of traditional modes of instruction? Why not, as stated in the opening paragraph, apply the "engineering approach" to teaching?

[1] Alvin C. Eurich, "More Effective Faculty Utilization", JOURNAL OF ENGINEERING EDUCATION, Vol. 51, No. 10 (June 1961), pp. 779-783.

Through the resources for more effective and efficient communication developed by engineers we should be able to learn through research how to make far better use of our engineering faculties. Much of the initiative for this research, incidentally, must come from the faculty rather than from administrative officials.

Background

During the Annual Meeting of the Society at Cornell in 1957, Dr. Eric A. Walker, a former Chairman of the Educational Methods Division, urged that group to undertake as a major project the promoting and encouraging of research in engineering education. Such research, he stated, should be as rigorous, comprehensive, and thorough as any other research, and should be deemed just as respectable for engineering teachers to conduct.

Subsequent to Dr. Walker's recommendations and challenge at Cornell, both the Educational Methods Division and the Engineering College Research Council gave considerable attention to the matter of research in engineering education. One of the significant products of their endeavors was the first compilation of a catalog of research projects in engineering education that either were in progress or recently completed. This compilation, which was presented by Dr. Harry W. Case, of UCLA, during the Annual Meeting at Purdue in June of 1960, provided useful information of the "where we are and what we have done thus far" variety for persons interested in considering research in engineering education.

Another useful compilation was a report by W. R. Hatch and Ann Bennet, entitled "Research on Teaching in Engineering and Related Subjects,"[2] which appeared in the October 1960 issue of the JOURNAL OF ENGINEERING EDUCATION. They reported research that had been done or published between 1956 and 1960 and which had been listed previously in the U. S. Office of Education Publication, "Clearing House of Studies on Higher Education."

Not necessarily related to the foregoing but another relevant background development was the appointment in 1956 of the Committee on the Development of Engineering Faculties (CDEF), sometimes referred to as the "Hazen Committee." CDEF organized its study into three parts: recruitment, development, and utilization—of engineering faculties.

It will be recalled that the CDEF was discharged at its own request last year, that a special published report appeared in the May 1960 JOURNAL OF ENGINEERING EDUCATION,[3] and that Harold Foecke presented an oral report to the Society at a General Session during the Annual Meeting at Purdue in 1960. The Committee suggested that implementation of its recommendations be carried out by other appropriate groups. Consequently, Dr. Eric Walker, then as President of the ASEE, asked the Educational Methods Division to undertake responsibility for determining ways of implementing the third facet of the CDEF study—that of utilization of faculty.

Research on Engineering Faculty Utilization

In accepting President Walker's charge the Educational Methods Division planned a mid-winter invitational conference for "Research on Engineering Faculty Utilization." The purpose of the conference was to:

a) Evaluate and disseminate information among the participants regarding the present status of research relevant to faculty utilization.
b) Relate such information to the contemporary engineering education scene.
c) Make recommendations regarding research needs which will provide

[2] W. R. Hatch, and Ann Bennet, "Research on Teaching in Engineering and Related Subjects", JOURNAL OF ENGINEERING EDUCATION, Vol. 51, No. 1 (October 1960), pp. 48-63.

[3] Harold A. Foecke, "Engineering Faculty Recruitment, Development, and Utilization," JOURNAL OF ENGINEERING EDUCATION, Vol. 50, No. 9 (May 1960), pp. 757-828.

additional information for the guidance of engineering education tomorrow.

The "Faculty Utilization" Conference, provided with funds from the Westinghouse Educational Foundation, was held at the Westinghouse Educational Center in Pittsburgh on January 9, 10, and 11, 1961.

So that the spirit and content of that conference can be brought to the attention of as large a segment of the ASEE as possible, attempts are being made to disseminate the results of the conference through:

a) A brief report at the 1961 Annual Meeting at the University of Kentucky.
b) Distribution of available conference papers and summaries upon request.
c) Publication of a summary report and of selected papers.
d) The establishment of teams which stand ready to assist with the planning and presentation of programs on faculty utilization at the request of sections and institutions.

In his keynote address to the conference, ASEE Vice President Howard Barlow, Washington State Institute of Technology, charged the group: "New ideas, new methods, new concepts, new devices, and above all a renaissance of thinking is needed if we are to handle successfully even a fraction of the task which faces us. From the neophyte teaching assistant to the deans of engineering, we must challenge our current methods." Conference participant Harold Foecke, Notre Dame University, reviewed the activities of the now defunct Committee on the Development of Engineering Faculties and emphasized their concern that the problem of faculty utilization be more thoroughly studied. Harry Case, UCLA, from his survey of engineering deans, noted paucity of bona fide research studies on faculty utilization with the possible exception of class size studies, television, and teaching machines. Roland Trathen reviewed RPI's research studies of class size, and Arnold Roe, UCLA, discussed independent study and programmed learning research. Leslie Greenhill, Penn State, in a provocative review of research on "physical aids to faculty" noted the results of such diverse devices as television, faculty offices, a cinema register, and the academic calendar. Paul Symonds, Brown, reviewed the use of undergraduate assistants as part of a discussion on "human aids." A pilot study of the use of faculty time was the unique contribution of John Ritchey, Purdue. Jack Alford, Harvey Mudd, discussed some of the faculty utilization problems of a new college. Otis Lancaster, Penn State, expressed concern over the non-teaching duties of engineering faculty members.

The first day was concluded by a provocative address by Dr. Alvin C. Eurich in which he challenged engineers to direct their attention and ingenuity to tomorrow's challenging problems in higher education.

To provide a contemporary context from which to view the problem of faculty utilization Gordon Brown, MIT, noted the explosion of new knowledge, new interdisciplinary developments, the unique features of engineering syntheses in a project context, and the importance of continually facilitating the exchange of ideas among researchers, teachers, and students. L. M. K. Boelter, UCLA, viewed his concern over a decreasing proportion of the best minds in the country now entering engineering, the role of the federal government as a prime contractor for research, the need of a more comprehensive view of engineering systems, the declining role of higher educational institutions in the development of new knowledge, and the importance of cataloging our natural, man-made and human resources and needs.

Merritt Williamson, Penn State, emphasized the dual responsibility of faculty members and administrators in guarding against technical obsolescence and presented specific ideas of how this might be done.

The immediate result of the conference was to develop a two-part report (1) a series of specific recommendations of policies and practices that should in

crease faculty utilization, and (2) a list of research needs on faculty utilization that can be presently identified. The report follows.

1. Policies and practices that should increase faculty utilization immediately were described by the group as follows:
   a) Replicate and duplicate desirable educational research studies in other institutions after they have been completed in the originating institution.
      Examples: Slide Rule Film, use of "Mari" (Motivation and Response Indicator), further experimentation using undergraduate and graduate students as supplementary to the faculty, etc.
   b) Streamline student scheduling procedures using computers to relieve faculty of some duties except those necessary for advising students.
   c) Re-establish work on the Catalog of Instructional Aids.
   d) Collect and disseminate information on unique features of classrooms and laboratories that increase learning.
   e) Increase the use of non-engineering personnel to relieve faculty of routine tasks.
   f) Institute the use of labor-saving devices to conserve time of faculty (dictaphone, verifax, closed-circuit TV, examination of records).
   g) Scrutinize all activities to ascertain what savings can be made in faculty time on paper work, committee work (for example, size and number of committees).
   h) Take care to avoid proliferation in undergraduate and graduate courses in order to conserve faculty time and increase their effectiveness.
   i) Support cross-fertilization among disciplines.
   j) Improve the leave of absence policy for either industry or another institution. This is needed at all levels.
   k) Recognize the positive effect on faculty members of strong encouragement by the dean or department chairman.
   l) Encourage continuing outside consulting work, both for the professional development of the individual and to bring research work to campus.
   m) Clarify all patent relationships with the university.
   n) Concern should be expressed about a system which will pigeonhole a faculty member into narrow discipline.
   o) Consider establishing a chair of Professor of Engineering Education in a number of institutions.
   p) All institutions should encourage the faculty to develop means for evaluating good teaching.
   q) Each school should study the constraints that exist in that school which interfere with the best pedagogy.
2. As ascertained by the Conference, general research needs on faculty utilization include the following:
   a) Application of operations research techniques to our systems of engineering education and its parts to identify the problems, their nature and severity.
   b) Efforts to define more carefully objectives, to devise more consciously means for the attainment of these goals, and to evaluate more systematically the degree of success in achieving them. (Could include such considerations as faculty development as well as learning.)
   c) Determination of a better allocation of function among elements which promote success of our system—distinguishing first of all between the human and machine functions.
   d) Research on the further development of more precise standards of

measurement of the variables involved in educational experimentation.

e) Efforts to design educational experiments on a sounder and more scientific basis, at the same time developing criteria for the evaluation of such designs.

f) More research on the nature of the learning process as it applies to engineering education and, especially, to the nature of learning in the design area.

g) More research on the project method as a means of promoting student learning.

h) Further study of techniques for shifting to the learner more responsibility for his intellectual growth.

i) Additional study of means of giving to the student earlier feedback on the degree of his success in achieving learning objectives.

j) Development of standardized achievement tests in more subject matter areas and steps to make these tests more readily available.

k) Regional cooperation among institutions in establishment of faculty teams for the development of the programmed learning experience in selected course areas.

l) Development of more films of a motivational nature to assist the teacher in this key function.

m) Extension of the study of the use of faculty time by the work sampling technique to a broader sample of the engineering teaching profession (studies of ways of reducing drudgery and duties of a subprofessional nature might be included).

To facilitate the development of some of the above areas, the Educational Methods Division is establishing a number of task groups, principally those outlined below.

Intercommunications: To serve the members of the Division and of the Society at large by continuously bringing to their attention in appropriate ways (e.g. abstracts in the JOURNAL, or newsletter, etc.) studies, books, articles, and the like which are relevant to problems of engineering education but which do not normally appear in the literature read by most engineering educators. (Chairman—Harry W. Case, University of California, Los Angeles)

Educational Media: To develop and keep current a catalog or "register" (perhaps in looseleaf form) of various movies, film strips, video tapes, slides, models, recordings, etc. which are useful in some aspect of engineering teaching; including also a listing of the sources, cost, potentials and drawbacks of various types of projectors, tape recorders, television equipment, etc. (Chairman—Edward J. Rising, University of Massachusetts, Amherst)

Programmed Learning: To compare and relate all of the different types of situations (lecture, laboratory, independent study, seminar, use of teaching machines) in which a planned "program" of learning experiences may be devised to secure the achievement of various kinds of learning (principles, skills, facts, attitudes, etc.); to plan and conduct experiments on the effectiveness of the different learning situations. (Chairman—Arnold Roe, University of California, Los Angeles)

Educational "Models and Systems Engineering: To explore the applicability of the operations research technique to the system of engineering education to more clearly identify the operations, functions, and interrelationships of the various aspects of the system (students, facilities, faculty, curricula, professional societies, etc.); to determine the feasibility of holding an invitational conference on this theme next year. (Chairman—W. K. LeBold, Purdue University, Lafayette, Indiana)

Persons who are interested in any of the task groups are invited to contact the chairmen of those groups.

It is hoped that all ASEE members—both instructors and administrators—will give more than passing consideration to

the value of and need for research in engineering education, that both will develop an interest in such research to the point of participation, that their participation will be rewarding for each, that administrators will encourage staff members to do educational research as well as technical research, and that due recognition will be given to those who perform outstanding research. And, in view of the present and anticipated manpower situation with regard to engineering staff, it is suggested that this educational research be directed toward accomplishing more effective faculty utilization. There is a wonderful opportunity to apply our celebrated "engineering approach" to the important and necessary task of finding ways of educating more students, of doing a better job of it, and of accomplishing it through more effective utilization of engineering faculty.

Volunteer Teaching Program at Stanford

JOSEPH M. PETTIT

Dean of Engineering,
Stanford University,
Stanford, California

This will serve as a brief report on a program that the Department of Electrical Engineering at Stanford University has operated on a modest scale for eleven years. Initiative and direction of the program has been ably provided by Professors H. H. Skilling and W. W. Harman.

The program has several novel features. Its objective is to provide an opportunity for a mature graduate student to have the experience of conducting a lecture class for one full academic quarter. This necessitates a special arrangement, because it is our general policy to assign graduate students who are employed as teaching assistants only to laboratory work and paper correcting; it is our preference to use regular faculty in the formal lecture courses.

This is not to say that regular faculty are automatically perfect in their lecturing ability. Indeed, if they were the program to be described would never succeed. This program is voluntary both in the sense that a graduate student volunteers for the lecturing duties, and, just as important, some undergraduate students must volunteer to enroll in these classes. Hence if the regular lecturer were so obviously perfect, we would have no volunteer students.

The motivations for a special arrangement are several, and seem to be valid enough so that we have repeatedly been

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able to organize between 5 and 11 of these special sections each year since the program began. The graduate student who wishes to volunteer for the lecturing assignment is usually a student who has interest in a teaching career, even though this interest may be only tentative. Indeed he may undertake the teaching assignment to help him reach a better decision about his career. In addition, he may be studying for his oral examinations for the Ph.D. and have been advised that lecturing experience in a basic course will help him in this preparation.

The motivation for the graduate student is strong enough to make it unnecessary to pay him for this experience.[1] Indeed this very absence of salary heightens the motivation of the undergraduate students in their decision to volunteer to take a course in this experimental way. It assures them that their lecturer must be strongly interested in rendering conscientious service.

The volunteering process occurs in the following way. The graduate student makes known his availability to the professor in charge, and a suitable course is agreed upon. This is typically the introductory electrical engineering course taken by all engineering students, or basic follow-up courses in electric circuits or electromagnetic fields. Such classes are usually taught in large sections, of perhaps 40 students. This factor provides another incentive when it is announced in the class that a volunteer section is available, and that this new section will be limited to about 10 students. An opportunity is thereby offered for a small-group experience in which there is far more interchange between instructor and student. Also, when volunteers are called for, they are informed that they will be free at any time to return to the main lecture class; this has only occurred once.

The volunteer students are also assured that the grading in the small section will not be different from that in the main class, and indeed it is our usual practice to supervise the grading carefully and to submit all students to the same final examination.

Supervision is of course important, although the amount of it required will be variable among the student lectures. The professor in charge of the course plans the coverage of subject matter, etc., although the student lecturer is given the opportunity to compose problem assignments and examination questions.

He also has the opportunity for as much consultation with a senior professor as he may wish on such matters as lecturing techniques. There is no formal preparation for the lecturing, and he must make his own transition from a listener to a lecturer. His experience as listener is recent, or usually concurrent, so he is all too aware of the differences between good and bad lecturing. Actually he is probably more preoccupied with organizing the subject matter in his own mind for presentation than he is with refining his platform techniques.

As previously mentioned, we have had from five to eleven volunteer sections each year, and this without benefit of any particular recruiting effort. Most of the volunteer lecturers hear of the opportunity through a seminar we conduct during the winter quarter of each year for graduate students interested in the teaching profession. In the seminar we have a variety of guest speakers, together with discussions based on student-prepared material. This seminar, attracting an attendance of 15 to 25 students, has like the volunteer teaching program completed more than a decade of successful existence.

It might be helpful to establish numerical perspective by pointing out the fact that we graduate about 25 Ph.D.'s a year in electrical engineering, hence about one in five of these students participates in the voluntary teaching program. The student during his career usually conducts only one class in a given course on the voluntary basis; after that he might reasonably expect to be paid!

[1]Units of academic credit can be given, however, and in an amount equal to the unit value of the course being taught.

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Candid Comments

This section is open to comments on articles in the JOURNAL or on engineering education in general. Send comments to the Editor, JOURNAL OF ENGINEERING EDUCATION, University of Illinois, Urbana, Illinois.

The Challenge to Engineers

Indications are becoming more and more numerous that the engineering profession must revitalize itself. A most significant indication of this need is the trend of college enrollments toward science rather than engineering. As Dean Ryder pointed out at a recent IRE meeting, statistical trends away from engineering among American youth may be more serious than many realize because of the masking effect of increased numbers of foreign graduate students.

Another indication of the need for revitalization is the growing numbers of splinter groups. An axiom of strategy is "divide and conquer." If the engineering profession allows products to divide it, will not the products conquer it? How many "kinds" of engineers can you name? Now, how many branches of physics are there? The breadth of a workman's skill is measured by the tools he can use and not by the variety of products on which he works. Similarly, the breadth of an engineer's creativity is measured by the branches of science he can apply rather than by the variety of products on which he works.

The electrical engineering profession has become plagued with product-identification just as widely as other engineering professions. These splinter groups have justified themselves on the basis that the parent group had become stagnant and did not fill the needs of the young engineers. On this basis the Institute of Radio Engineers has grown to a dominating place in the electrical engineering profession, even though the number of electrical engineers needed to create radios is relatively negligible. What new institution will splinter when and if the IRE becomes obsolete in ten years as predicted as a possibility at the recent IRE convention by Professor Fano of M.I.T.

Is splintering the only practical method by which we can advance? This process reminds one of the Mad Hatter's Tea Party—move to a fresh place and leave the debris for someone else to encounter. Certainly, engineers are not unique in having followed this short-sighted policy. It is a quality of modern civilization which requires aggressive, conscientious effort and a sense of duty to overcome. Witness the slums and debris in all our cities and towns where obsolescence has been allowed to produce eyesores to civic pride. Witness the depletion of our natural resources. I do not suggest becoming string-savers, but, as New York City so aptly expresses it by signs on their trash receptacles, we should all "cast a ballot for a clean city." Similarly, we must all cast a ballot for a revitalized engineering profession and not discourage students from engineering by the spectacle of the debris of obsolete practices and societies. Perhaps we should incorporate better feedback or planned obsolescence with limited life to ensure better action towards periodic revitalization.

Certainly, the ideas expressed here were not originated by the writer. I doubt if the source of any idea can be located very reliably. The need for revitalization of processes is as old as man himself. Our youth are its symbol and our graves are its witness. As engineers we should be able to detect the signs of obsolescence in our engineering organizations and, if necessary, recreate entirely new organizations to replace the old and not merely to compete with them.

Is it possible that engineering itself is obsolete? I do not think so, but rather favor the idea that science is analysis and

engineering is synthesis. However, engineers must be able to analyze as well as synthesize, and therefore deserve more extensive training than scientists.

The prime objective of engineering is creativity. I also suggest that the opportunity to create is the most tempting lure that can be presented to youth. Have we stifled the creative urges of engineering students by requiring more class-hours than are required for science majors, and by teaching many technician-type courses such as mechanical drawing and routine design courses in circuits, machines, and other standardized equipment? Have we misguided students by teaching them how to design present products while they think they are learning how to design products not yet created? Do they think they have a better chance of creating new products if they devote their education to learning science rather than accepted engineering methods? If a large corporation wants to develop an entirely new machine such as a magnetohydrodynamic generator to whom would they assign the development, to a physicist or to an engineer? Surely, the application of science to the creation of a new device or system is the soul of engineering. If there is any doubt that an engineer would be selected for such work I submit there is also that much doubt that we are training true engineers.

J. P. NEAL
Associate Professor of
Electrical Engineering
University of Illinois

To Eric A. Walker

In response to your invitation for comments on "The Question of Establishing a National Academy of Engineering" (JOURNAL, May 1961, p. 698) I am pleased to respond as follows:

1. It is quite likely that a proposal for establishing a National Academy of Engineering would be favorably received in national political circles. It could be dramatized as a sister academy of the National Academy of Sciences which was established 100 years ago by Abraham Lincoln.

2. The exploitation of science and technology for purposes which are harmful to the welfare of our country is one of today's great historical facts. Much of this exploitation is taking place in our own country, and at high political levels.

3. There is an abundance of regrettable evidence that the venerable National Academy of Sciences has been consistently ignored whenever unproven claims of scientific advances have been communicated to the American people. The silence of the Academy in such matters has been interpreted as tacit acceptance of such claims. The most elementary principles of good sportsmanship at the international level, (similar to public witnessing of the Olympic Games in the field of sports) have not been observed in the fields of science and technology.

4. There is no reason to presume that, if a National Academy of Engineering were to be established, it could rectify this situation.

5. One of the objectives of a proposed new academy is stated to be the granting of recognition and honor to a limited number of individuals who may have distinguished themselves in the field of engineering. It would seem that the traditional functions of our National Professional Societies are quite adequate for such purposes.

6. Before considering the establishment of a new agency relating to the profession of engineering, it would be highly desirable to honestly appraise our existing agencies, and particularly the areas of their current failures.

7. Although we take great pride in our engineering profession, it behooves us to listen to the words of competent observers of the national scene, such as:

> Any observant conservative must be struck by the feebleness of those organizations, in the United States, which ought to be the defenders of true community. Our chief bulwark against the total state, indeed, is today the inertia of constitutional law, not the intelligent protest of voluntary groups. The lawyers and the doctors, indeed, are reasonably vigilant; but

very few other elements of the free community seem to apprehend the danger in which we stand. (*Prospects for Conservatives*, Russell Kirk. Chicago, Gateway Editions. 1956. p. 143.)

In summary, I wish to record myself as opposed to the idea of establishing a National Academy of Engineering. You are at liberty to quote this letter and release it for publication in the JOURNAL OF ENGINEERING EDUCATION.

ADOLPH J. ACKERMAN
Consulting Engineer
Madison, Wisconsin

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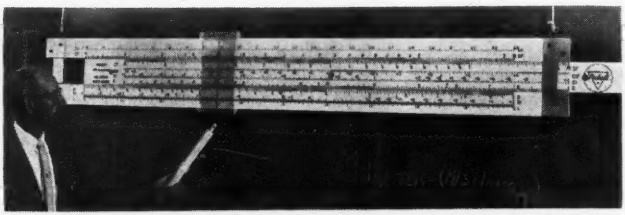

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We have prepared a talk which has been given a number of times and if our schedule permits, we are glad to present it before groups anywhere. A list of the members of our Committee is attached and I am sure any of them will also be glad to help you.

Sincerely,

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Cooperative Education — Jan. 22-24, 1962 — Washington, D. C.
Information: M. J. Vaccaro, Goddard Space Flight Center, Greenbelt, Md.

Engineering Graphics — Jan. 1962 — University of Wisconsin
Information: K. G. Shiels, Assistant Dean of Engineering, University of Wisconsin, Madison, Wisconsin.

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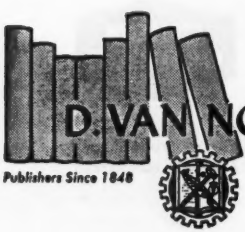

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